# JUST-IN-TIME LOGISTICS: DOES IT FULFILL THE SURFACE NAVY'S REQUIREMENTS TO SUPPORT THE NATIONAL MILITARY STRATEGY

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# ABSTRACT

JUST-IN-TIME LOGISTICS: DOES IT FULFILL THE SURFACE NAVY'S REPAIR PARTS REQUIREMENTS TO SUPPORT THE NATIONAL MILITARY STRATEGY? by LCDR Ernest D. Harden II, 138 pages.

Since the end of the Cold War, the U.S. has been drawing down its military. The national military strategy was altered to require the military to be able to defeat two adversaries in two nearly simultaneous major theater wars. With the drawdown came reduced infrastructures and funding. The Navy has been investigating methods to reduce costs of supporting its warfighting forces while providing reliable and timely support. It turned to industry to find the most efficient means of providing the necessary support to surface ships while supporting two nearly simultaneous major theater wars. The most prominent of the changes implemented from industry has been the Just-in-Time logistics model. This model requires reduced inventories and greater reliance on contractors and transportation to meet the repair parts needs of the surface Navy. Comparison of strategic capabilities, Navy theater repair parts distribution capabilities, and conditions of the battlefield with fleet requirements will provide a framework for determining if Just-in-Time logistics can meet the repair parts requirements of the surface Navy during two nearly simultaneous major theater wars.

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| | |
|---|---|
| 3PL | Third Party Logistics |
| AFDD | Air Force Doctrine Document |
| AMC | Air Mobility Command |
| APOD | Aerial Port of Debarkation |
| APOE | Aerial Port of Embarkation |
| ASN | Advanced Shipping Notice |
| BPA | Blanket Purchase Agreement |
| BRAC | Base Realignment and Closure |
| CINC | Commander in Chief |
| CLS | Contractor Logistics Support |
| COD | Carrier Onboard Delivery |
| DLA | Defense Logistics Agency |
| DOD | Department of Defense |
| DSC | Defense Supply Center |
| DSCC | Defense Supply Center, Columbus Ohio |
| DVD | Direct Vendor Delivery |
| FISC | Fleet and Industrial Supply Center |
| FM | Field Manual |
| FOB | Free Onboard |
| GAO | Government Accounting Office |
| GPS | Global Positioning System |
| GSA | General Services Administration |

| | |
|---|---|
| INMARSAT | International Maritime Satellite |
| ITV | In-Transit Visibility |
| JIT | Just-in-Time |
| JLOTS | Joint Logistics Over the Shore |
| JTAV | Joint Total Asset Visibility |
| LOTS | Logistics Over the Shore |
| MCDP | Marine Corps Doctrine Publication |
| MILALOC | Military Air Lines of Communication |
| MSC | Military Sealift Command |
| MTW | Major Theater War |
| NATO | North Atlantic Treaty Organization |
| NAVICP | Naval Inventory Control Point |
| NAVSUP | Naval Supply Systems Command |
| NWCF | Navy Working Capital Fund |
| PBL | Performance Based Logistics |
| PLS | Palletized Loading System |
| RAS | Replenishment at Sea |
| RBS | Readiness Based Sparing |
| SAC 207 | Special Accounting Classification 207 |
| SALTS | Streamlined Automated Logistics Transmission System |
| SPOD | Seaport of Debarkation |
| ST | Student Text |
| TAV | Total Asset Visibility |

| | |
|---|---|
| US | United States |
| USTC | United States Transportation Command |
| VBSS | Visit, Board, Search and Seizure |
| VM | Velocity Management |

# CHAPTER 1

# INTRODUCTION

> If military logistics is done well, it is a significant combat multiplier. . . . If it is not done well, it can lead to disaster. There is an old saw: "for want of a nail, a shoe was lost; for want of a shoe, the horse was lost. . . ." Ultimately, the war was lost, all for want of a nail. Logistics is that important to warfighting.[1]
>
> Mark J. O'Konski, "Technology Improves Warfighters' Logistics Lifeline"

This quotation represents the importance of logistics in wartime. Although it is referring to Army logistics, the same is true for Navy logistics. Fleet Admiral E. J. King said, "I don't know what the hell this 'logistics' is that Marshall is always talking about, but I want some of it."[2] There are many other quotations stating the importance of logistics in war, not to mention papers and illustrations throughout history on what happens when logistics is not conducted properly. However, in the past ten years, congressional support and budgets have consistently shrunk for the armed services, despite an increase in operational commitments. The end of the cold war in 1989 has been the driving factor in reduced resources to the military. Without a specific threat to prepare for, the country and its leaders decided military resources should be reduced for a perceived decreased threat. This desire to take advantage of the "peace dividend" of the post-cold war years produced a decrease in the amount of capital available to maintain the military. Therefore, the Navy, along with the rest of the Department of Defense (DOD), has been searching for opportunities to reduce the cost of operating its forces while maintaining acceptable support to the fleet. In the past five years, the Navy has adopted a model for logistics from private industry to decrease its cost of operations while maintaining its combat power, the just-in-time (JIT) logistics model.

Recently, the Government Accounting Office (GAO) released a report stating that a large amount of Defense inventory was excess to military needs.

> The Department [of Defense] had no demand for about $11 billion, or 29 percent, of $37 billion of the inventory that exceeded current requirements as of September 30, 1997, but did have customer demands for the remaining $26 billion. Assuming customer demands remain unchanged, $3.4 billion of this inventory would last 20 or more years and $658 million would last more than 100 years.[3]

Obviously, substantial improvement needed to be made in the way the military ordered and stored material. The military desires to use the money tied up in procuring stocks and storing them to invest in research and development. Although there are reasons for maintaining some of the items mentioned above, the dollar value was extremely high for the size of inventory and needed to be reduced. By changing the method of maintaining the logistics tail, the military, including the Navy, hopes to reduce this figure substantially, while maintaining support to the war fighters across the world, even during a two nearly simultaneous major theater war scenario, as discussed in *Joint Vision 2010*.

However, there is much concern among warfighters that the JIT method will not meet the requirements set by *Joint Vision 2010* to fight two nearly simultaneous major theater wars. Junior and midgrade officers throughout the Navy continue to voice their doubt that the new system can respond to shifting requirements, that there are enough transportation resources, and that support is too shallow, and, when equipment breaks in the heat of battle, there will be enough spare parts to draw on because they have not been manufactured yet. The former Chief of the Supply Corps, Rear Admiral Hickman, noted these concerns of increased risk linked with timely delivery by preferring to call the new system "manufacturer-carried inventory."[4] These are serious concerns, and they will be addressed in this paper. This leads up to the primary question: Will the JIT logistics model be sufficient to support surface Navy repair parts requirements for two nearly simultaneous major theater wars? These requirements would be based on deploying around four-to-five carrier battle groups and about three-to-four amphibious forces.[5]

The previous system of just-in-case logistics created problems of its own. Because so much material was held "just in case," inventories were too large. With older inventory tracking systems, items were sometimes hard to find, especially in an emergency situation when time is condensed. In addition, cost to buy the inventories was very high compared to the readiness reflected in the fleet. Also, costs to maintain the inventory were high, although this is not significant compared to the initial purchase cost of the inventory. Because many items were time sensitive, the older the inventory got, the more likely it was that some of the items would fail when issued, contributing even more to the problem of poor inventory quality, along with inability to find items. In addition, many stored items would become obsolete, wasting an even larger portion of scarce resources to buy and later dispose of useless inventory.

The JIT logistics method relies on knowledge of the inventory on hand, knowledge of requirements, and a reliable, flexible transportation system. In addition, it relies on the supplier's ability to provide smaller quantities, and his ability to reproduce items quickly. Some of these requirements are derived from assumptions, while others are implemented to meet the needs of the customer. The Navy's mission, as defined in *Joint Vision 2010*, is to fight two major theater wars nearly simultaneously. Therefore, the Navy defines the requirement as being able to logistically support fighting two nearly simultaneous major theater wars.

Although a new president and cabinet took office this year and changes are expected to the *National Security Strategy* and the *National Military Strategy*, they are current as of the creation of this document. In addition, the facts, principles and analyses used in this work will apply under different military strategies. Capacities and the size of requirements may change, but the framework laid out in this document should be useful to future planners.

The principles of logistics are responsiveness, simplicity, flexibility, economy, attainability, sustainability, and survivability.[6] By changing the logistics system to JIT, the Navy has not significantly changed the principles of logistics. However, the new system emphasizes different principles than the just-in-case system and emphasizes them in different ways than the old system. It also applies modern technologies that the old system did not use to full advantage. Some of the new technologies are Total Asset Visibility (TAV), improved transportation methods, improved ordering methods, and, presumably, improved manufacturing and acquisition techniques. The last two improvements are only assumed, because the Navy does not control the suppliers' methods of meeting requirements. If JIT logistics can provide adequate services to the fleet, it can significantly reduce cost of inventories. Alternatively, if JIT logistics cannot meet the demand required during a two major theater war scenario, the transportation system will be overstretched, and some units will be forced to operate at reduced capability. Although it is unlikely the National Command Authority would permit an inadequate force to operate for extended periods in a hostile environment, initially this situation could lead to loss of capability in the force, delay of mission completion, loss of equipment and material, and even loss of life.

The Navy implementation of JIT logistics can affect more than just Navy preparedness. Because the Navy directly supports amphibious operations, the Marine Corps could equally suffer if problems with preparedness arise. In addition, the Navy provides support to the Army and Air Force during certain joint and multinational operations, and these departments could suffer significantly also. If aircraft carriers and Tomahawk cruise missile carrying ships could not support the Air Force with strategic air strikes or air interdiction, the Air Force would have to bring in additional assets to complete the mission and place additional pilots in danger. If the Navy could not support Tomahawk strikes, close air support, or naval surface fire support, the Army or Marine Corps are placed at greater risk to accomplish their missions.

How the Navy can best solve its logistics problems during two major theater wars is the essential question. The nations' response during two major theater wars could determine its effectiveness against two opponents. Since the Navy is usually the first to arrive on station with significant combat power, the preparedness of its forces is crucial to determining how the conflict will develop. If the Navy arrives on station unprepared, the adversary may take advantage of the situation to further his political goals and possibly prolong a war. Conversely, if the Navy shows up with substantial firepower, then the enemy may not desire to engage in war and to pursue his goals through less hostile channels.

The original question, Will the JIT logistics model be sufficient to support the Navy's requirements for two major theater wars? opens additional questions for study.

How different is this new system of logistics from the legacy system? Is the JIT logistics system better than the old models? What will the requirements be when supporting two major theater wars? What assumptions have been made to support the current models? How do current inventories of supplies affect the JIT logistics model? Does the Navy have excess inventory? Will these inventories continue to be available in the future? Is enough transportation capacity available in the right quantities and types to support two major theater wars? If there is no problem with future support with the JIT logistics model, why is there a continuing question? If there is a shortfall in availability of material or transportation, how significant is it? What can be done about it? Can commercial JIT practices be expanded in the military? Should they be? Each of these questions needs to be answered to determine the final answer to the original question. The secondary questions refine the primary question to determine first if JIT logistics, as it is applied today, can provide adequate support in two nearly simultaneous major theater wars. They also refine the first question to determine if JIT logistics is currently the ideal solution to support the Navy's mission requirements, or if another system is available that will meet the needs of the Navy better.

Below is a list of important definitions and descriptions of terms used throughout the document.

Defense Logistics Agency (DLA). DLA manages materiel and supplies for the Defense Department that is not carried individually by the services. DLA's mission includes managing over 4 million consumable items and processing more than 30 million annual distribution actions.[7]

Direct vendor delivery (DVD). Contracts are established to have material delivered directly to the user, vice to a central receiving point or storage location.

*Forward… From the Sea*. The Navy's vision for operating in a joint littoral environment, noting shifts in emphasis and new technologies fielded in the late 1990s and shortly after 2000.

Frequency channel. Frequency channels are established airlift routes with specific known throughput capacities. They include the aircraft assigned to that route, airports, ground transportation, and material handling equipment.

Frustrated material. Frustrated material is items or pallets of material that has been mislabeled or lost at a shipping point and cannot be forwarded to its final destination without additional research. Additional research includes contacting the original shipper, opening the container to determine if there are shipping labels inside the box, or conducting an inventory of material at the shipping location to locate missing material.

International Maritime Satellite (INMARSAT). INMARSAT provides commercial communication links to the telephone systems of the world. Ships routinely use it to conduct logistics transactions and other functions requiring telephone communications.

In-transit visibility (ITV). ITV is the ability to track material from its storage location to its final destination. There are several methods being developed to increase ITV across industry and the military that will be discussed in chapter 4.

JIT logistics. The Navy's application of JIT systems from civilian industry is termed JIT logistics. JIT systems in civilian industry means order placement and delivery that is synchronized with production schedules to reduce or minimize inventory costs.[8] This includes reducing inventories to zero or near zero and ordering material in the smallest batch sizes possible to realize savings in various areas from inventory management to manufacturing and production processes. Since the DOD and the Navy do not produce physical items, or manufacture particular materials, the part of JIT systems that applies to the Navy is JIT inventory management and JIT purchasing procedures. These areas rely on a robust transportation capability and Total Asset Visibility (TAV).

Joint TAV (JTAV). JTAV is the capability to provide users with timely and accurate information on the location, movement, status, and identity of units, personnel, equipment and supplies. JTAV includes in-process, in-storage and in-transit business practices.[9] TAV applies to the individual services separately.

*Joint Vision 2010*. The DOD's vision of how the military will support national security goals to 2010, taking advantage of technologies to be developed and incorporating emerging threats to the national interest. *Joint Vision 2020* was recently released and is the follow-on to *Joint Vision 2010*, noting some technologies will not be developed and fielded until after 2010. The primary change between the two is a renewed emphasis on personnel development, operations other than war, and an increased emphasis on interoperability between services and other agencies. It does not have a significant impact on logistics methods.

Just-in-Case Logistics. Items are stocked based on criticality of the item to a system. It is not demand based, but based on the requirement to ensure that the item is always available because the system will not function without it. For example, the Navy would require screws for ships to be stocked because, although demand is very low for this item, the Navy cannot afford to have a ship waiting for months for a screw to be manufactured. This is especially true if the screw is used on the guidance systems for Tomahawk missiles, making it a crucial link to maintaining the ship in war-fighting condition. The demand based logistics model is a model that uses specific formulas to determine the quantity of material required to meet a specific need for a certain length of time. Depending on the level at which items are being stocked, the time used for the calculations can vary from days at the lowest levels to years at the national level.

Major Theater War (MTW). MTWs are large military operations that occur in a geographically specific region of the world. War is considered the most demanding of military operations, and US forces are expected to defeat any adversary and control any situation across the full range of military operations.[10]

Naval Inventory Control Point (NAVICP). NAVICP manages all items specific to Navy weapon systems. It also manages items that are in common with other weapon systems in other services when it is designated the lead agent. It provides program and supply support for the weapons systems that keep Naval forces mission ready.[11]

Navy Working Capital Fund (NWCF). The NWCF is a rotating fund to supply the Navy with material managed by the NAVICP. It uses funds generated by the sale of material to organizations to purchase new stocks of material.

Readiness-Based-Sparing (RBS). RBS is a relatively new model to compute amount of repair parts to hold in inventory taking into account an entire systems criticality, number of times the repair part fails, number of times other parts in the system fail, and length of time it takes to receive the repair part.

Replenishment at Sea (RAS). RAS is the process of transferring material while ships are still underway, without having to enter port or stop. RAS takes three forms, vertical replenishment by helicopter, connected replenishment when two ships connect to each other (only method for transferring fuel), and carrier onboard delivery where a fixed-wing aircraft delivers material and personnel to an aircraft carrier from shore or another aircraft carrier.

Requirements channel. Requirements channels are airlift routes established when a service requests them based on the volume of cargo. They include the aircraft assigned to that route, airports, ground transportation, and material handling equipment.

Streamlined Automated Logistics Transmission System (SALTS). SALTS was designed during the Gulf War in 1991 to alleviate problems transmitting logistics requirements from the Persian Gulf. It uses INMARSAT commercial telephone lines to pass information in compressed format to the NAVICP in the U.S.

SUP 21. SUP 21 is a new organization to coordinate modernization initiatives in the Navy supply system. A board of professional logisticians reviews and establishes timelines and priorities, as well as monitoring progress, to coordinate efforts to achieve efficient modernization of the Navy supply system.

Visit, Board, Search and Seizure (VBSS). VBSS is a procedure to verify the legitimacy of material and personnel being carried on a vessel. It consists of querying the vessel, sending a boarding party to it, conducting an inspection, and determining if there is contraband aboard.[12]

Limitations for this thesis are weaknesses imposed by constraints or restrictions beyond the control of the researcher.[13] There are various limitations presented when researching this project. Certain categories of supply cannot be researched in an unclassified document. Requirements will be difficult to verify, and lay outside the scope of this thesis, so they will be assumed to be correct based on *Joint Vision 2010* and *Forward… From the Sea.* Some logistics data are modified occasionally to meet the needs of DOD, and these modifications are not readily apparent. However, the data should be useful from an operational perspective and will be relied on for information. In addition, if the *National Military Strategy* changes, the thesis could still have application because the facts, principles and analyses used in this work will apply under different military strategies. Capacities and the size of requirements may change, but the framework laid out in this document should be useful to future planners.

Delimitations to this thesis are constraints that are imposed on the scope or content of the work by the researcher so that the research will be feasible.[14] Because this topic can be a substantial undertaking, the thesis will focus on an individual class of supply for an individual set of platforms. Several categories of supply will be excluded from consideration. Subsistence, personal use items, and base support supplies are easily obtained from many sources, and substitutions can quickly cover any problems arising from shortfalls. Ammunition stocks are classified and they will be excluded from investigation. The Navy does not routinely deal in major end items for surface ships, and they will be excluded from consideration. Other civil affairs and civil management items are required in such special circumstances that they provide inconsistent demands on the system and therefore will be excluded from consideration. In addition, the Navy does not routinely handle this class of items. Textile requirements do not significantly affect the war-fighting capability of the Navy and will be excluded. Petroleum products provide unique challenges, since they are required in large quantities and require special handling. Although this could be a very interesting class of supply to review, it will be excluded from this paper to keep focus on the major topic area for most Navy personnel concerned with JIT logistics. Medical supplies rely on a nearly independent supply system and will not be reviewed. Surface Warfare trained officers have presented most of the questions concerning JIT logistics to the author, so he will only investigate repair parts management for surface ships.

The JIT systems incorporate a variety of fields in the private sector, but for the Navy only two aspects are relevant to its inventories. The first is JIT purchasing and the second is JIT inventory management. Therefore, this paper will examine these two areas of JIT systems.

Increased efficiencies in DOD transportation systems are occurring continuously so only those in use today will be considered in this thesis because others are continuously in development. Examples of increased efficiencies include material tracking systems and synchronization of the modes of transportation. These directly affect distribution and the ability to use the JIT inventory management system. In addition, new advances in transportation management should merely increase JIT effectiveness as modes of transportation become faster, more reliable, and tracking systems become more accurate.

JIT logistics has been implemented across the Navy and will affect the Navy's ability to meet its commitments in the future. The standard the Navy is training and organizing toward is to fight and win in two nearly simultaneous major theater wars, as laid out in *Joint Vision 2020* and *Forward… From the Sea*. The new logistics system reduces inventories and relies on throughput and a robust transportation system to provide support. The old just-in-case logistics system relied on large stockpiles of material to meet requirements. Change was necessitated when congressional and public pressure reduced funding to the military to realize the peace dividend from the collapse of the Soviet Union. Many naval officers question the validity of the JIT logistics system, since it has no reserve of repair parts, which would be required in a time of crisis. The history of the Navy's requirements and logistics systems to meet those requirements will be discussed in greater depth in chapter 2.

There are numerous reference materials for whether the JIT logistics system is or is not an improvement. These will be categorized and evaluated to determine if JIT logistics is adequate to meet the Navy's requirements for the future. In addition, references from business and other DOD agencies will be reviewed to determine if there are more lessons to be learned from other organizations and methods of conducting logistics.

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[13]U.S. Army Command and General Staff College, ST 20-10, *Master of Military Art and Science (MMAS) Research and Thesis* (Fort Leavenworth, KS: U.S. Army CGSC, July 2000), 19.

[14]Ibid.

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# CHAPTER 2

# HISTORY AND REVIEW OF PERTINENT LITERATURE

This chapter will provide a general history of the logistics system for the Navy, including recent factors bringing about change. It will also include a selective review of the literature relating to the topic. Additionally, it includes general pertinent descriptions of programs occurring in the other services and industry. This chapter consists of four sections. First, the way things used to be done, a narrative history, will be covered. Second, commercial business practices are influencing the way the military applies JIT logistics. Third, the services are updating their logistics programs based on commercial business practices. Fourth, this paper will contribute to existing literature on this topic.

## Background

The Navy of the 1980s was larger than it is now.[1] The U.S. was preparing to fight World War III with the Soviet Union, and the Navy was preparing to meet its enemy on the high seas. The defense budget was growing, and the U.S. had a strong economy. At this time, defense contractors were plentiful, and the defense industry was also growing, providing more than enough opportunity for contractors to find work. The Navy was attempting to achieve a 600-ship Navy and was even activating the old battleships to meet short-term requirements for more ships to lead battle groups and a shore bombardment capability with the 16-inch guns.

During this time, when the military was a growing industry and budgets were greater than today, the DOD made the assumption that a large amount of material would be required in theater and at depots to support a war with the Communist bloc countries.

This was probably true, considering the enemy was on the other side of the Iron Curtain in central Europe, and had at least as many weapons as the North Atlantic Treaty Organization (NATO) forces did. The military would have to conduct a defensive action until the U.S. could deploy more forces in Europe. On the high seas, the Navy would be faced with an opponent brandishing antiship cruise missiles and attack submarines of various qualities and designs. The fleets would have to operate away from bases for extended periods to keep the sea lines of communication open to Europe. Thus, Replenishment-at-Sea (RAS) was crucial to keep battle groups capable of fighting while remaining at sea. Intermediate bases were established in many overseas areas including Guam, Italy, Japan, and Hawaii. The Navy also established a small base in Bahrain to support Persian Gulf operations. The Navy had several older classes of ships to support and dozens of bases in the U.S. to provide this support across the country.

In 1989, however, the Soviet bloc in Eastern Europe, and then the Soviet Union itself, collapsed. This left the military with a huge amount of material prepared to conduct war in central Europe and on the high seas. The Navy began to draw down before the Gulf War began, but had not made much progress by the beginning of the conflict. When the Gulf War began, most of the Navy's assets were located around the world and had to be moved to the Persian Gulf.

However, for sustainment the Navy had a lesser problem than other services because it was used to conducting operations away from bases for extended periods of time. Still, it faced problems in distribution. Because the base in Bahrain was small, the Navy built up some supplies in the United Arab Emirates and Saudi Arabia. Consumption was lower than predicted because the consumption factors used were based on the Vietnam War, when destroyers were shelling beaches and when jets were dropping tons of bombs per sortie, prior to precision-guided munitions. Repair parts consumption for surface ships was much less than expected.[2] Sealift requirements were greater than the Navy's and the Military Sealift Command's (MSC) capabilities, but these requirements were primarily for the other services. The Navy experienced the greatest shortages in airlift, where it competed for space with the other services. The problems of lack of in-transit visibility (ITV) and Total Asset Visibility (TAV) meant forces in theater could not tell what was in transit or what was already in theater. Hence, because of lack of confidence in the supply system, many repair parts available in theater were ordered again, and items in transit were also ordered again since no one could tell when the material would arrive or where it was. The duplicate reorders and the huge amount of material required rapidly overwhelmed Air Force lift capabilities, causing backlogs in various ports of entry and debarkation. Logisticians in Bahrain, coordinating the movement of material in theater for the Navy, did not have a view of the tactical picture, thus delaying shipment of repair parts to ships off the coast. Last, the number of repair parts messages became larger the longer ships were in the area of operations. Since requests for repair parts were administrative in nature, they received low priorities. This created a backlog of messages for parts, further delaying shipment of required material.[3]

The lessons taken from the Gulf War include the need to transfer information quickly, maintain visibility of assets in transit, and mark material for easy identification. Some initiatives began even before the Gulf War was over to correct some of these problems. The most recognized was the creation of the Streamlined Automated Logistics Transmission System (SALTS) to submit repair parts requirements data using the commercial International Maritime Satellite (INMARSAT) system to transmit this information without having to rely on overwhelmed military communication systems. However, the major discovery of the Gulf War was that Navy afloat logistics requirements in war differ little from those of peacetime, with the major difference being in the use of live ammunition.[4] There are several books, articles, reports, and theses compiling information from the Gulf War, and some attempt to distill lessons learned. Several will be used in this thesis, primarily from articles and theses, since these tend to be more concise than books and reports. In addition, these articles and theses provide valuable information on JIT logistics initiatives that were created after 1991.

After the Gulf War, the drawdown of DOD became more important. Secretary of Defense Les Aspin initiated the Bottom-Up Review, which grew into the Quadrennial Defense Review. In these reviews, force structure was analyzed to determine where excesses existed compared to requirements. The Base Realignment and Closure (BRAC) process was implemented to reduce excess infrastructure. This process had dramatic effects in the Navy's logistics systems because now many forward bases were closed that had provided intermediate staging areas. In addition, many of the warehousing functions were consolidated as bases closed, eliminating additional stockage points. Defense industries were shrinking and major consolidations were the only way for some corporations to survive. Many contractors and subcontractors either went out of business or converted to supplying the private sector. A good example is the merger of Lockheed and Martin-Marietta forming Lockheed-Martin Corporation. As these actions were occurring, the Navy quickly realized they needed to improve the logistics system to meet the requirements of the future. Without forward bases and reduced national infrastructure, the Navy lost some of its flexibility to support forces forward deployed.

The most significant requirement initiating change was a substantial decrease in funding. The Navy and DOD saw declining budgets from 1990 to 1999.[5] With reduced funds, the Navy was looking for savings anywhere it could. Any money saved would be put toward research and development to prepare for the future. By reducing funds, fewer repair parts could be purchased to maintain the fleet or to provide an emergency stockpile of repair parts in case demand for those parts suddenly went up.

The next major change affecting the Navy supply system was the delineation of requirements and the creation of goals and concepts to meet them. The *National Military Strategy* delineated the requirement to create "a force capable of fighting and winning two major regional conflicts nearly simultaneously."[6] The Bottom-Up Review initially established these requirements, but the *National Military Strategy* further articulated them and various logistics initiatives were created to aid in achieving this goal. Later, *Joint Vision 2010* established the framework for achieving this goal within the joint and international arena by providing additional guidelines. It also provided broad goals to focus progress in advancing the military structure. It emphasized the incorporation of innovation through technology and information operations to provide improvements throughout the military. It also established the operational concept of focused logistics.[7] *Forward… From the Sea* provided direction and goals specific to the Navy, including forward presence and power projection. More specifically, it stated the need to focus on power projection ashore, in the littoral environment.[8] Although an older document, it is still in use today. A newer edition was released in 1997, but it focused almost exclusively on operational issues. The 1994 version was referenced in Navy posture statements to Congress in 2000. The latest guidance in requirements is *Joint Vision 2020*. It reemphasizes concepts laid out in *Joint Vision 2010*, but also emphasizes military operations other than war, information operations, and command and control. More directly affecting this thesis, it redefined focused logistics.

> The ability to provide the joint force the right personnel, equipment, and supplies in the right place, at the right time, and in the right quantity, across the full range of military operations. This will be made possible through a real-time, web-based information system providing total asset visibility as part of a common relevant operational picture, effectively linking the operator and logistician across Services and support agencies. Through transformational innovations to organizations and processes, focused logistics will provide the joint warfighter with support for all functions.[9]

This definition, however, provides only one portion of the method to achieve success. It does not discuss transportation, ITV, warehousing, or purchasing. This is addressed by each service individually.

### Commercial Business Practices

Commercial industry has proceeded rapidly with various techniques to improve logistics, whereas the military has traditionally paid little attention to logistics until the eve of battle when logistical problems become acute. Industry continually has been improving its logistics functions over the years, but a starting point must be determined. The current wave of business innovations came from overseas, specifically from Japan. These business changes migrated to the U.S., were gradually incorporated throughout various industries, and have become the standard in America. Although some industries still use older methods of logistics, they usually are small companies that can manage their logistics with a single person or a small group.

After World War II, Japan was attempting to rebuild its economy and invited several business leaders from America to train its leadership in modern management techniques. The most famous of these was Dr. W. Edwards Deming, who taught the virtues of total quality management and total quality control. Using these methods, the Japanese began producing goods of quality equivalent to their competitors. However, Japan has a strong working class and not much else. They are significantly restricted in natural resources and depend on raw materials from outside their country to accomplish their goals. In 1973, when the oil embargo struck the U.S. and the world, the Japanese felt the pinch more than the U.S. They immediately began looking for solutions to the high cost of raw materials so they could remain competitive throughout the world. Japan adopted JIT techniques based on their own cultural history, which relies on the individual to produce a good product and avoid embarrassment. By using JIT, whenever a defective item was received, the employee immediately identified the problem and notified someone to get a replacement. With JIT logistics, there were no large piles of items the employee could sort through to locate an item that was not defective. The supplier, when notified of the defective item, immediately took steps to correct it. Since only a few items were shipped at a time, chances were there were only a few defective parts, and not a whole truckload. The Japanese also had a unique transportation system. Because the country was relatively small and its industries tended to cluster close together, travel times between factories were reduced. This contributed to their success with JIT production techniques.  Plus, Japanese manufacturers encouraged their suppliers to locate close to their factories, to further reduce travel time.[10]

The U.S. industry began to see the success of Japanese manufacturing techniques and realized they, too, must modernize practices if they were going to compete.  In the early 1980s, total quality management returned to the U.S., as well as a new method of logistics called just-in-time logistics.  One of the biggest influences in bringing JIT to the U.S. was Dr. Richard Schonberger.  His book, *Japanese Manufacturing Techniques*, will be cited several times in this thesis.  He traveled to Japan in the 1970s and 1980s to observe Japanese manufacturers and culture to better understand the improvements they made in manufacturing.  When he came back to the U.S., he observed a few Japanese manufacturers in the U.S. using the same techniques and achieving similar results.  He concluded their success was not based on cultural reasons, but on a different style of manufacturing and the complementing logistics practices associated with it.  Note commercial industry began using JIT logistics as a method for improving manufacturing techniques.  They sought improvements in quality and increased flexibility to meet shifting customer demands.  The military initiated JIT logistics practices to improve the efficiency of its logistics agencies by reducing inventory and making the distribution system more flexible.  The short-term goal was to reduce the cost of procuring and storing repair parts, not improving manufacturing techniques.  There are other books concerning JIT, but Dr. Schonberger laid the foundation for the American methods of JIT.  More modern books will be referenced to provide the most modern management techniques in U.S. industry.  In addition, there also are articles concerning JIT logistics in trade magazines and periodicals that will be used in this thesis.

The newest methods discussed in current literature is JIT II, which is purchasing integration with suppliers, to eliminate buyers, planners, and sales representatives. This new change was brought about to increase cooperation between suppliers and manufacturers and to reduce costs associated with the purchasing function, such as labor and infrastructure. This is unlikely to apply to government purchasing methods because of contracting rules, so it will only be reviewed as a trend in industry.

## The Services' Applications of JIT Logistics

Each of the services performs its logistics functions essentially the same as the Navy, with slight variations. All have different names for their programs, and all have embraced JIT logistics as the answer to loss of resources and pressure from congress to reduce expenses. Focused Logistics, as stated in *Joint Vision 2020*, integrates individual services' logistics through information technology to provide Joint Total Asset Visibility (JTAV).[11] This includes material in storage and in transit. *Joint Vision 2020* also focuses on providing accurate information to warfighters to aid in making decisions and states that the military will attempt to use commercial business practices to the best advantage to the military. Although it mentions increased transportation capabilities, there is no additional information on what types of improvements in transportation to expect. In addition, there are various joint publications establishing guidelines for the services to interact together and with other nations and agencies. *Joint Vision 2010: Focused Logistics, A Joint Logistics Roadmap* discusses the various areas the military is collectively attempting to improve. This publication provides direction for each of the services to make changes. Joint Pub 4-0 states, "A CINC's authority is generally confined to the theater, while logistic support beyond the theater is usually a Service's responsibility."[12] This certifies that each service has a separate logistics system that must be interoperable with those of the other services.

The Marine Corps has followed the Navy's examples of using Readiness-Based-Sparing (RBS) and later JIT logistics, to implement their current logistics modernization effort called Precision Logistics and Logistics Over the Shore (LOTS). These efforts tailor logistics support to be provided from the sea, rather than building large infrastructures on shore. In addition, the Marine Corps has several ships with a brigade's worth of material pre-positioned in key areas of the world that have less than two weeks sailing time to anywhere in the world. These pre-positioned stocks are supposed to supply a Marine force for thirty days. After that, the Marine force expects to receive logistic support from other services in the area, primarily the Army. There are various Marine Corps doctrine publications, specifically the MCDP 4 series, discussing its logistics methods. Theses provide additional analyses of the Marine Corps use of JIT logistics.

The Army has recently created its own version of JIT logistics with Velocity Management (VM) to support Force XXI. The Army Force XXI process uses a variety of different field training experiments in which soldiers use a blend of old and new equipment under realistic conditions to test and evaluate their applicability.[13] The Army logistics system, however, has unique challenges, such as battlefield distribution and force protection problems not seen in Naval logistics. Still, the Army experiences can provide valuable insights. One area in which the Army has excelled is in the use of palletized loading systems, to ship material configured for the end user from the factory.

This avoids having to break down various pallets and reconstituting them in intermediate staging areas. The Army is focusing heavily on reducing its logistical footprint in a theater by eliminating intermediate storage areas in the division, corps, and echelons above corps in theater. Also, the Army uses Navy maritime pre-positioning ships to get logistics resources in theater quicker. These ships serve the same purposes as Marine Corps pre-positioning assets. Logistics for the Army is more integrated with command decision making than for the other services. It is described in a separate chapter in FM 100-5, *Operations*. This field manual provides older methods of conducting logistics for the Army since it has been in use since 1993. There are theses and articles in periodicals and magazines, like *Army Logistician*, that provide useful analysis of the Army logistics system and its improvements. However with ST 3-0 out, which is the student version FM 3-0, the follow-on of FM 100-5, useful information on the Army's new logistics procedures has been provided. It discusses combat service support reach operations, which involves sending forward only the minimal number of combat service support assets required. The service support is provided from intermediate staging bases, forward bases, and the U.S. This reduces the number and size of logistics assets, allowing combat units to move more freely without having to bring a large amount of repair parts and other logistics assets with them.

The Air Force created its own version of JIT logistics with lean logistics. Their focus has been on reducing the logistics-cycle time to increase readiness while decreasing dependency on large inventories. Logistics-cycle time is the time from generation of the requisition to receipt of the material by the requisitioner. Several processes influence cycle time, but if the overall time can be reduced, a more flexible supply system can be achieved while stocking fewer parts. AFDD 2-4, *Combat Support*, provides doctrine for Air Force logistics. In addition, there are more than a dozen articles in periodicals like the *Air Force Journal of Logistics* available, along with research theses from the Air Force Institute of Technology. However, the Air Force provides logistic support, as the Navy does for the other services, with strategic and theater airlift. The only apparently significant changes the Air Force has incorporated into its strategic lift are placing command and control under Air Mobility Command and the introduction of the C-17 aircraft, capable of transporting oversize cargo. There are additional doctrinal instructions in the AFDD 2-6, *Air Mobility Operations* series. More than a dozen research papers also have been generated detailing airlift shortfalls. Note that there is never enough airlift capability, and distribution is a matter of assigning priorities while managing the airlift platforms and aerial ports of embarkation and debarkation.

To understand how JIT logistics will affect the Navy repair parts supply system, this paper will present a short introduction to general supply. Most of the procedures discussed here are common throughout the military, though some of the participants may be changed. First, in figure 1, a requirement is generated aboard ship for a repair part. The Supply Department checks to see if it is held on board. If not, they initiate a requisition to their parent Fleet and Industrial Supply Center (step 1), or FISC, usually located where the ship is homeported. If the FISC does not have it, a requisition referral is generated to the Naval Inventory Control Point (step 2), or NAVICP. The requisition then is referred to another FISC that does have the material (step 3). The other FISC issues the material to the ship (step 4) and reports it to NAVICP (step 5). NAVICP issues a contract to backfill the FISC (step 6). Then, the material is procured and sent to the

FISC that issued the part (step 7). Last, the FISC reports receipt of the material to NAVICP (step 8).[14] If the Defense Logistics Agency (DLA) manages the repair part instead of the Navy, then step 2 goes to a Defense Supply Center (DSC), as in figure 2, with corresponding reporting to the DSC. This is the current method of conducting general supply actions. In the current model, items stored on a ship are considered end use items and are not visible throughout the Navy. Items stored on aircraft carriers or on auxiliary, repair, or large deck amphibious ships are considered retail items. They are in a rotating pool called Special Accounting Classification (SAC) 207 in the Navy Working Capital Fund (NWCF). Items managed by DLA but held by the Navy are also retail items because the Navy purchased them from DLA using the Navy Working Capital Fund. Finally, repair parts managed by the Navy that are carried by FISCs and NAVICP are in the wholesale system of the Navy Working Capital Fund. The differences in these categories involves who paid for them and how much visibility they have throughout the military.

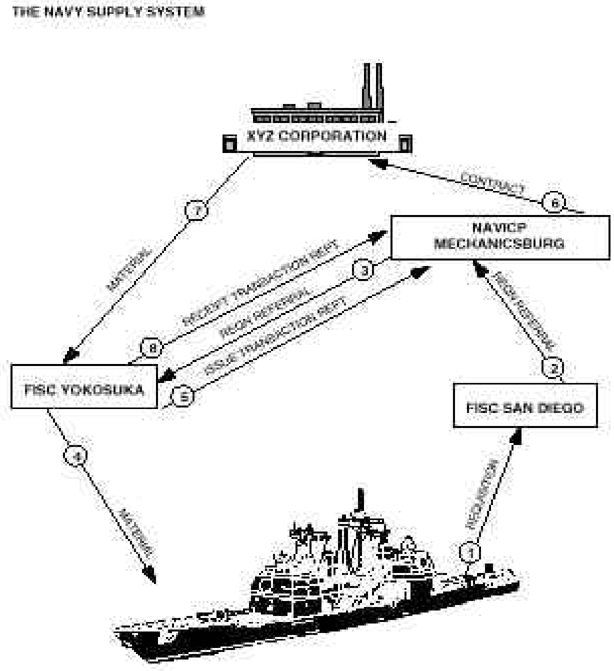


Fig. 1. Source: Naval Supply Systems Command, NAVSUP P-485, *Naval Supply Procedures, vol. 1, Afloat Supply* (Mechanicsburg, PA: October 1997), 1-29.

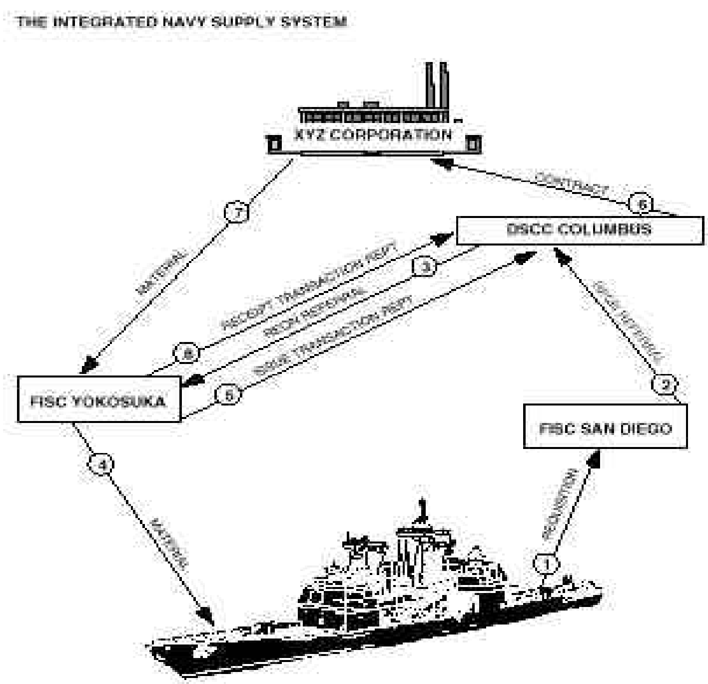


Fig. 2. Source: Naval Supply Systems Command, NAVSUP P-485, *Naval Supply Procedures, vol. 1, Afloat Supply* (Mechanicsburg, PA: October 1997), 1-32.

TAV is blurring the lines between end use, retail and wholesale stocks. JTAV will continue to reduce the barriers between these stocks. By allowing the system to see any repair part in any location around the world held by any government activity, all repair parts become available to support units anywhere in the world. This means repair parts will no longer be retail or end use since anyone anywhere can request that item and its use will not be restricted to a small number of customers. FISCs have also changed their method of doing business. They have reduced the amount of material management they do and transferred much of that responsibility to DLA. This means that FISC shelves have DLA-owned material on them rather than Navy-owned material. FISCs are doing less supply management and more supplier management, blurring the position of the FISCs in relation to the types of stock they manage. They have retail and wholesale items in the warehouse, and some of these repair parts are managed by DLA instead of the Navy. This reduces the amount of repair parts in the system because FISC does not own its own stock of a certain repair part while DLA owns another stock of repair parts. This reduces the number of organizations owning various inventories of the same repair parts. This is consistent with JIT logistics, since DLA is essentially a supplier to the Navy, while the Navy holds no inventory of that particular repair part.

The Navy applies JIT logistics across its $15 billion material inventory in selected fashion. Many items are protected as emergency stocks. These are assumed to be insurance items. The Navy has no plans to reduce this “safety level” stock, which is about one-third of the total Navy inventory.[15] The JIT logistics applies to the rest of the inventory, and the Navy is working to get most of the other two-thirds outsourced. By outsourcing, private industry will be required to provide the material, and the Navy will not stock the repair parts at the same levels they have in the past.

The Navy Supply Systems Command has established the SUP 21 executive steering group to head a larger effort to reengineer the Navy logistics system in many areas. The stated mission of SUP 21 is:

> To enable the Navy Supply System's vision of One Touch Supply by delivering world class, customer-centric logistics support through globally integrated supply chain management. By managing change created by customer needs and reduced resources, SUP-21 efforts will lead the Naval Supply Systems Command into the twenty first century as a manager of suppliers rather than supplies.[16]

Their efforts coordinate and synchronize various programs that overlap into multiple areas to ensure resources are applied logically and in a systematic manner to achieve modernization goals for the Navy Supply Systems Command. The SUP 21 office can provide information on new programs to implement JIT logistics. This paper will focus on JIT inventory management and JIT purchasing. Other initiatives affecting both of these are direct vendor delivery (DVD), which means the vendor delivers the material directly to the requisitioner from his commercial stock. The life cycle management will also affect inventories because the contract for the life cycle of a larger assembly will include the supply of repair parts. Standards are established in the contracts for delivery times and amounts required to be on hand. Another initiative is contractor logistics support (CLS), where a single vendor manages the overall logistics process for the entire weapon system, including repair parts management, technical manuals, field upgrades, and maintenance in certain cases. This is more comprehensive than life cycle management, because the Navy still manages the logistics process and the vendor provides the repair parts and, in certain circumstances, the shipping costs. Last, the Navy is pursuing third party logistics (3PL), in which another party is brought in to manage a supply system. The SUP 21 initiative has created a body of information available through the Internet and in periodicals, such as the *Supply Corps Newsletter*. There are additional resources on these new initiatives from periodicals and magazines, such as *Military Review* and *Joint Forces Quarterly*.

Each service has embraced JIT logistics and modified it to meet service's particular needs. The Air Force was the first to begin this change in 1991, with the Army and Navy following, and finally the Marine Corps has accepted it to comply with Navy standard operating procedures. In addition, the Navy trains the Marine Corps logisticians. Each service, however, has unique challenges, requiring unique applications of JIT logistics. These applications will be discussed further in chapter 4.

## Contributions to this Subject

This paper will link the JIT logistics changes for Navy surface ship repair parts management to the Navy's ability to sustain two nearly simultaneous major regional conflicts. It will expand the information available to others researching the modernization of logistics at the turn of the century and how it met the requirements for the Navy. It also will provide a bibliography for follow-on study in this area. Then, it will provide an opportunity to analyze the changes occurring in logistics, and provide some conclusions on whether it will meet the requirements laid out in the *National*

*Military Strategy*. Finally, it will recommend future areas of research to investigate other aspects of meeting logistical requirements and the effects of JIT logistics.

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[1]Chief of Naval Operations, *Forward… From the Sea* (Washington, DC: United States Printing Office, 1994), 9.

[2]David Schrady, "Combatant Logistics Command and Control for the Joint Force Commander," *Naval War College Review* 52, no. 3 (1999): 49.

[3]Ibid., 53.

[4]Ibid., 54.

[5]Chief of Naval Operations. *Forward… From the Sea*, 9.

[6]Chairman of the Joint Chiefs of Staff, *National Military Strategy: Shape, Respond, Prepare Now-A Military Strategy for a New Era* (Washington, DC: United States Government Printing Office, 1997), 3.

[7]Chairman of the Joint Chiefs of Staff, *Joint Vision 2010* (Washington, DC: United States Printing Office, 1996), 13, 16.

[8]Chief of Naval Operations, *Forward… From the Sea*, 1.

[9]Director for Strategic Plans and Policy (J-5), Joint Chiefs of Staff, *Joint Vision 2020* (Washington, DC: United States Government Printing Office, June 2000), 24.

[10]Richard J. Schonberger, *Japanese Manufacturing Techniques: Nine Hidden Lessons in Simplicity* (New York: The Free Press, 1982), 1.

[11]Director for Strategic Plans and Policy (J-5), Joint Chiefs of Staff. *Joint Vision 2020*, 24.

[12]Director of Logistics (J-4), Joint Chiefs of Staff, Joint Pub 4-0, *Doctrine for Logistic Support of Joint Operations* (Washington, DC: United States Printing Office, 6 April 2000), I-4.

[13]Secretary of the Army and Chief of Staff of the Army, "A Statement on the Posture of the United States Army Fiscal Year 2000." Presented to the Committees and Subcommittees of the United States Senate and the House of Representatives first session

106th Congress  [article on-line] (20 January 2000, accessed 5 December 2000); available from http://www.army.mil/aps/00/aps00.htm#page1; Internet.

[14] Naval Supply Systems Command, NAVSUP P-485, *Naval Supply Procedures, vol. 1, Afloat Supply* (Mechanicsburg, PA: October 1997), 1-27 to 1-31.

[15]SUP 21 Reengineering Office, "SUP 21 Reengineering Office Update." [presentation on-line] (26 January 2000, accessed 26 November 2000); available from http://www.navsup.navy.mil/main/business/sup21/01262000.ppt; Internet.

[16]Ibid., (accessed 5 December 2000).

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# CHAPTER 3

# RESEARCH METHODOLOGY

This chapter will review the methodology to be used to answer the original question of this thesis. The thesis is designed to analyze the capability of the just-in-time (JIT) logistics system for surface ship repair parts to meet the Navy's requirement of responding to two nearly simultaneous major theater wars. It will describe how data was collected and categorized, and how the analysis will be completed. It will include a description of how the primary and secondary questions of the thesis will be answered.

## Conducting the Research

The original topic for this paper was to analyze if the entire logistics system would meet the Navy's requirements in two nearly simultaneous major theater wars. However, as a review of the literature began, it became apparent there would be serious problems collecting information on this broad topic. An ammunition analysis was quickly ruled out because it required a review and a discussion of classified information and complicated the investigation. Subsistence, personal items and base support supplies were also ruled out because they can be obtained from many sources and substitutions are readily available, making analysis of JIT logistics with these items very difficult. Civil affairs and civil management also do not provide good representation for analysis because these items have inconsistent demands and are used only in special circumstances. The Navy does not routinely deal in major end items for surface ships, so they were excluded. Textile requirements do not affect the ability of the Navy to fight overseas so this class of item was excluded. Petroleum products have their own unique handling requirements, and much of it is required in bulk, so these items were excluded. Medical supplies have their own unique supply system so they were excluded from consideration in this paper. In the interest of completing the paper on time, it was further limited to repair parts support for surface ships since this is where the author possesses some experience.

When research began it became apparent there was enough information to create an analysis based on studies provided by various sources. Books were reviewed on this topic, but most applied to commercial industry. The next group of sources reviewed included research papers by other officers and corporations contracted by the Navy or the Department of Defense (DOD). These sources provided valuable information on previous research into various repair parts management techniques. Instructions and articles provided useful information on requirements. Last, reports and surveys conducted by the military, Government Accounting Office (GAO), and contracted corporations working for DOD produced information on requirements and capabilities.

## Categorizing the Research

The review of the research revealed several categories of information to determine the answer to the primary research question. Commercial industry was the first to use JIT logistics. However, the purpose of JIT logistics in commercial industry is substantially different than the purposes for the military services. Industry was primarily interested in improving manufacturing processes, whereas the Navy and DOD are interested in reforming repair parts management to reduce costs associated with maintaining these parts. Therefore, this category will be used to provide a foundation of JIT logistics principles and a comparison to other material management methods.

The other services have their own variations on implementation of JIT logistics. This category of information will help to determine the applicability of JIT logistics to the military and to the Navy. The material from the other services included articles, research papers, and publications on procedures. These references provide insights into the effectiveness of the program under various circumstances and some of the shortcomings of JIT logistics management. In addition, this category could be divided into current repair parts management techniques and previous techniques. The reason for two subcategories is because an analysis will be conducted to suggest why changes were made from the older systems to the newer ones, and the improvement or degradation of support provided by the new systems. In addition, this category could provide useful information on alternative repair parts management techniques that may be compared to the current system to determine which might be better.

Several articles and papers have been written on the previous logistics system of just-in-case logistics. These articles will be used to create a historical base on what was considered sufficient to meet the requirements of two nearly simultaneous major theater wars. Then a comparison will be made to determine if JIT logistics made improvements in readiness for the Navy in surface ship repair parts management, or at least did not degrade readiness. This base will also be used to determine if there are savings being realized in the storage or purchase of repair parts.

The final category the literature falls into is requirements and capabilities. The GAO, Navy audits, the Navy Inspector General, and corporations contracted by the Navy and DOD conducted research and audits into the efficiencies of various repair parts management systems.  These audits will provide information on the requirements for the Navy and capacities for supporting these requirements.  They will not, however, answer the final question because each audit only takes into account certain aspects of the logistics system.  The GAO audit,[1] for example, provided information on the DOD inventory.  Its analysis was limited to the value of the inventory and its age, not its effectiveness or the military's readiness rate.  In addition, government policy statements and instructions provide the basis for determining the requirements.  The *National Military Strategy* provided the fundamental requirement for the military to fight and win in two nearly simultaneous major theater wars.[2]

## Analyzing the Information

The information gathered from these sources has been consolidated into coherent areas for comparison.  Then, a comparative analysis will begin, starting with the Navy's mission and requirements to meet that mission.  Then, the research will provide the capability of the JIT logistics system.  A comparison of the requirements to the capabilities will answer the initial research question.  However, secondary questions remain and will require additional analysis.  Comparisons will have to be made to determine if JIT logistics is an improvement over the previous just-in-case logistics system.  Comparisons of other service and commercial applications will provide insight into other possible improvements in the Navy's application of the JIT logistics system.  This comparison may also provide information on other inventory management methods that are better suited for Navy application.  This could be especially useful if the JIT logistics system is not capable of meeting the Navy's requirements to fulfill its stated mission.

Figure 3 provides a representation of the method used to analyze data for this paper. By comparing the requirements of the surface Navy for repair parts in various scenarios and the capabilities of the battle groups, amphibious ready groups, and strategic transportation, the paper will answer the primary and secondary questions.

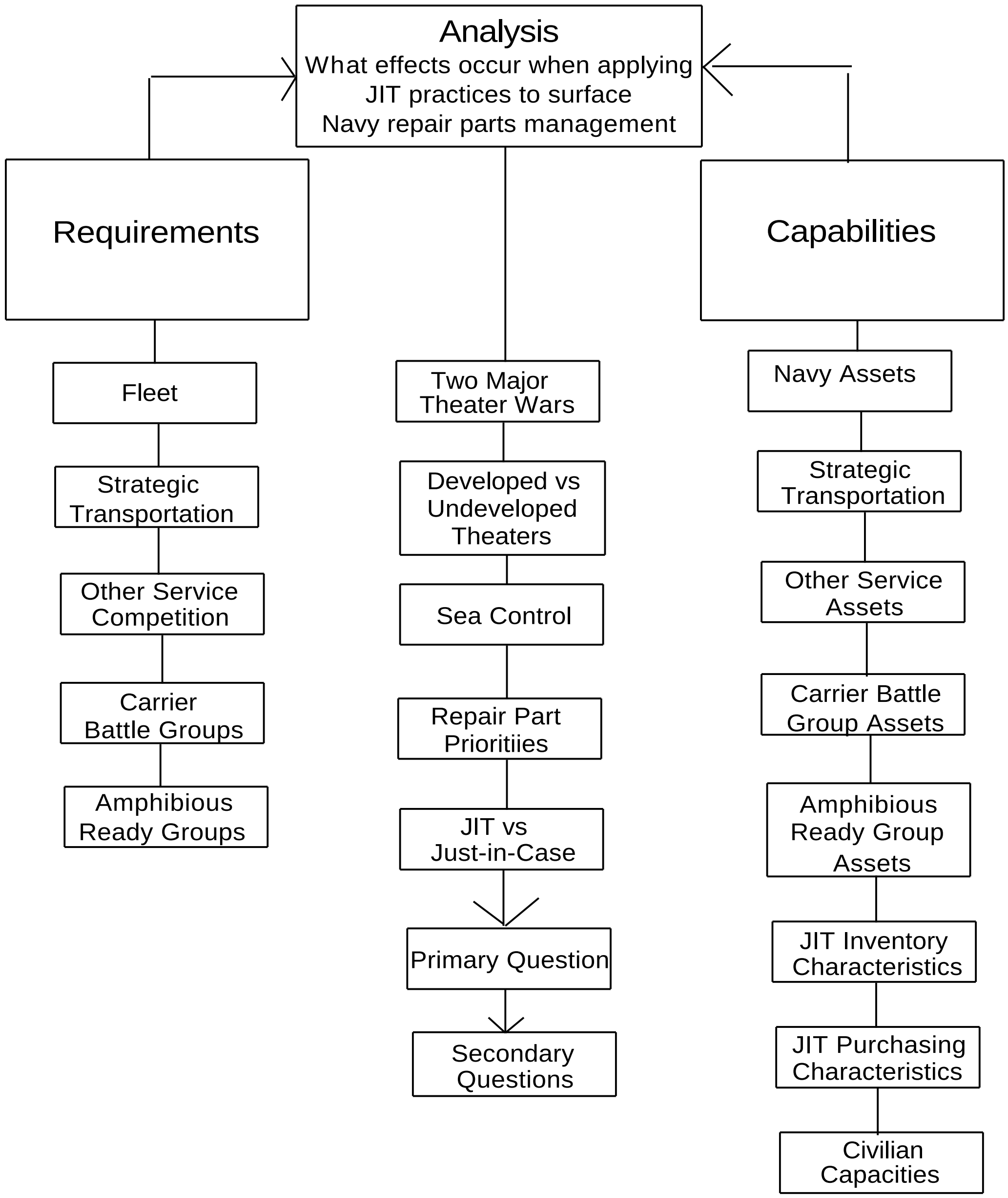


Fig. 3 Research Methodology

Conclusion

This paper will rely primarily on produced materials from various sources to answer questions on surface ship repair parts management to support the *National Military Strategy*. Analysis will be required to determine if the capabilities of the Navy will meet the requirements for two nearly simultaneous major theater wars.  The paper will also analyze the potential for other repair parts management systems to fulfill Navy requirements.  Finally, JIT logistics will be compared to newer management systems to determine if one may apply to the Navy better than the current logistics system.

Chapter 4 will organize the data and present a comparative analysis of previous and present logistics systems to provide insight into the best system for the Navy.  It will collect and analyze the data to produce Navy requirements and capabilities to meet those requirements.  The results of these analyses will produce the conclusions and recommendations in chapter 5.  Chapter 5 will also provide recommendations for follow-on research concerning this topic.

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[1]David R. Warren, "Report to the Chairman, Subcommittee on National Security, Veteran Affairs, and International Relations, Committee on Government Reform, House of Representatives.  Defense Inventory.  Status of Inventory and Purchases and their Relationship to Current Needs" (Washington, DC: General Accounting Office, April 1999), 1.

[2]Chairman of the Joint Chiefs of Staff,  *National Military Strategy: Shape, Respond, Prepare Now-A Military Strategy for a New Era* (Washington, DC: United States Government Printing Office, 1997), 3.

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# CHAPTER 4

# ANALYSIS

This chapter will describe the logistics requirements and capabilities for repair parts for Navy surface ships to support two nearly simultaneous major theater wars (MTW) as required in the *National Military Strategy*. Then, it will break down the various components of JIT logistics and apply them to the requirements laid out in the *National Military Strategy* and the capabilities discussed in this chapter. The JIT manufacturing system started in industry to meet industrial production needs. As stated in chapter 2, there are two areas where JIT logistics applies to the Navy logistics system for surface ship repair parts. The first is the inventory and distribution of repair parts. The second is the procurement of repair parts. Both of these will be further broken down into their essential characteristics and how they affect the Navy's military capabilities. Finally, the capabilities will be compared to the repair parts requirements of the Navy to determine if the JIT logistics system can meet the *National Military Strategy*. In chapters 4 and 5, there will be many references to ships and aircraft. Refer to Appendix A for a list of ships and aircraft and their general capabilities. Refer to Appendix B for pictures of the ships and aircraft.

## U.S. Fleet Requirements and Capabilities

Military requirements stem from those stated in the *National Military Strategy*, to be prepared to fight and win two nearly simultaneous major theater wars. The standard deployment for a major theater war is four to five carrier battle groups and three to four amphibious ready groups. These will require the same amount of repair parts for the ships when conducting combat operations as they would during normal peacetime steaming.[2] The battle groups and amphibious ready groups will be off the coast, at relatively close distance, to conduct operations in the range of their aircraft and provide a credible deterrent to any aggressor. These forces will probably remain on station for at least three months, and possibly six months or longer. As the ships remain on station longer, more major repairs are delayed. The expenditure of ordnance will be substantial as missiles and bombs are used during the campaign. Aircraft will probably experience increased failure rates as they are used continuously in high stress combat operations with rapid turnaround times. The other services and possibly other countries will also conduct a buildup of materiel, equipment, and men. The assumptions that go into establishing this scenario require closer examination.

## Size of the Force

The first assumption concerns the number of carrier battle groups and amphibious ready groups required to support two nearly simultaneous major theater wars. For the purposes of examination, assume there will be a standard number of ships in the battle groups, about six or fewer combatants supporting one CV or CVN. For example, the USS CONSTELLATION (CV-64) battle group deployed with five surface ships, two submarines, and an AOE.[3] For the amphibious ready group there are normally about four or fewer amphibious ships with one LHA or LHD. During combat operations, one of the command ships (LCC or AGF) would deploy to each region. The minesweeping fleet would deploy to the region requiring its services most, along with the minesweeping command ship USS INCHON (MCS-12). An average of four carrier battle groups will be in each theater, along with three amphibious ready groups. These forces will arrive gradually, the first carrier and amphibious ready group arriving within a week. The next carrier will have to deploy from the U.S. or another theater, requiring between one week and three weeks. The next two carriers and the last two amphibious ready groups will arrive between one and three months. This is a total force of 44 major combatant ships in each theater, with one theater also having the INCHON. The total deployed combat force would be about 89 ships, not including auxiliary ships. The Navy has 35 auxiliary ships dedicated to Navy operations exclusively. Most of these ships are operated by the Military Sealift Command (MSC) and are manned primarily by civilian merchant mariners. This could raise issues of putting civilians in harms way. It also reduces the number of preferred underway replenishment opportunities, as overtime has to be paid when replenishments are conducted outside normal working hours. However, operationally, MSC ships are traditionally used in the same manner as other auxiliary ships with all military crews. On average about 25 percent of the auxiliary ships are in a nondeployable status at any time because of maintenance or repair. This leaves 26 auxiliary ships available to support combat operations. Since the two major theater war scenario is the maximum extent to which the military is supposed to extend itself, all other requirements will be dropped. This will leave the entire fleet of auxiliary ships available for support to the theaters. This is an additional 13 ships per theater, and a total deployed force of 115 ships to the two theaters.

On 30 January 2001, there were two deployed carrier battle groups, with two amphibious ready groups. However, the entire Navy had 168 ships underway, including 21 submarines, for a total of 147 surface ships. This included 13 carriers, LHAs, LHDs, and MCS ships.[4] Assuming the Navy dropped all other commitments, the requirements to support Navy deployments to two major theater wars is no more than routine operations, with the exception of up to two additional capital ships (CV or LHA/LHD) instead of smaller ships. Since the capital ships bring significant transportation capability with them in their C-2A aircraft or MH-53E helicopters, they are unlikely to adversely affect repair parts distribution.

Ships will remain at sea a similar percentage of days as in a standard deployment, about 85 percent. The rest of the time they will be in port for repairs, loading various supplies, and transfers of personnel, as well as for crew morale. During the inport periods, the ships will load repair parts that could not be delivered sooner or were too large for aircraft or underway replenishment delivery.

## Sea Control

Stable consumption of repair parts, however, requires at least one basic assumption that may not be true. The Navy must possess maritime supremacy. This means the adversary cannot mount a credible threat against the Navy or other supply vessels. National leaders are somewhat casualty averse, and do not want any large numbers of casualties unless the American public is prepared to accept those losses. There are several credible threats from even the smallest potential adversaries that challenge this assumption. The nearly land locked nation of Iraq was able to mine its restricted access waters and deploy hundreds of floating mines during the Gulf War. Other countries possess credible sea and land launched antiship cruise missiles. Another threat is a single aircraft attacking a single ship on a kamikaze style mission to launch missiles or crash into it. In addition, more countries have diesel submarines that can be employed as a "force in being" to deter U.S. ships from getting close to the area of operations. The submarine's power is its stealth, and the threat of use of its capabilities provides the greatest deterrent to surface ships in a region. Possibly the most dangerous threat is available to almost any country. A merchant could mount a small missile or gun system and disguise it, similar to German surface raider practices in World War II. When the U.S. Navy conducts a routine Visit, Board, Search, and Seizure (VBSS) operation in close proximity to it, they can use the missile or gun to severely damage or cripple the Navy ship. However, enemy surface combatants pose no serious threat to U.S. forces, as they are easy to detect, track, and engage well beyond the horizon. If a Navy surface ship does get hit by any of these threats, there is a good chance it will require major repairs not capable of being conducted underway. It will have to enter port or be repaired in a floating dry-dock, allowing it to receive substantial supply support from that location.

The Navy will also require maritime supremacy along the sea lines of communication. Although this is likely to exist since there is no credible threat at sea in any region of the world, there are certain exceptions. Choke points throughout the world exist and can be exploited. Political concerns also are significant factors to that must be resolved. If Egypt decided nuclear powered vessels would not be allowed through the Suez Canal, this would delay arrival of the nuclear powered aircraft carriers and submarines. If an adversary's submarine began operating from Yemen or Somalia, or mining occurred in the Red Sea from the back of a fishing trawler, the entire Red Sea would no longer be secure. Anti-ship cruise missiles are always a threat when coming through the Strait of Hormuz. It is narrow there, and a current U.S. enemy borders one side of the strait. Although these scenarios are less likely to occur, they would delay operations to get repair parts to the theater. The most likely response would be for the U.S. to clear the sea lines of communication, which would take time. In the interim, the Navy would send its materiel around the choke point, delaying the vast majority of repair parts shipments. However, these delays would affect the lower priority materiel. The highest priority materiel would move by air.

If the Navy were restricted from entering a theater of operations because of a desire to avoid any casualties due to lack of maritime supremacy, this would not adversely affect providing repair parts support. The ships would be re-supplied in the same method whether they were 100 miles or 500 miles from the area of operations. There may be a negative effect on ability of smaller helicopters to deliver materiel, but the CH-53D, MH-53E, V-22A, and the C-2A have ranges that exceed 500 nautical miles.[5] Recently, the Marine Corps moved all CH-53D aircraft to reserve squadrons. In addition, it is unlikely the Navy would receive its support from the area where the conflict is taking place. From this information, by deduction, the Navy is more likely to establish or expand the operation of a base or forward logistics site in a safer location.

## Ship Repair and On Station Time

Generally, as time on station builds, more serious repairs are delayed. They are delayed because the ship does not have the capability to conduct the repair itself, not because of lack of repair parts. For example, if one of a ships four main engines suffers a catastrophic casualty because the rotor in the turbine is bent, the ship will probably continue to operate because it has three operational main engines. However, that type of damage to a turbine engine is not repairable while the ship is underway and the casualty will not be repaired until the ship can be removed to an intermediate maintenance activity or shipyard. The smaller the ship, the more likely it will require major maintenance, since it has less repair capability than the larger ships.

On-station time can also have an effect on repair parts available aboard ship. The highest priority materiel will not be adversely affected by the length of time on station, since this materiel will be pushed to the ship by expediters in the supply and transportation systems, but the lower priority materiel may be delayed. For example, bearing grease may not be considered a critical item, but it is bulky. It will most likely be moved by surface transportation, and will have a low priority in the supply system, as discussed in chapter 2. However, as time on station builds, more ships run low on grease, increasing requirements for it. If the materiel is not moving through the transportation channels, it will eventually become an item of high importance. Because of the large size of the Navy's auxiliary ships, loading repair parts and consumable items tend to not be a problem. The problem usually comes from not knowing where the materiel is and when the materiel can be transferred to the requiring unit. These topics will be discussed later in this chapter.

## Increased Ammunition Demand

As the two major theater wars progress, ammunition will be used rapidly. As has been illustrated in recent conflicts, the first ordnance to be used is the Tomahawk cruise missile, closely followed by precision-guided munitions. To reload Tomahawks, the ships must port, allowing repair parts to be distributed. The aircraft carrier, however, can receive precision-guided munitions underway from an AE, T-AE, or AOE. Each of these ships has large carrying capacity and can transfer large quantities of medium priority repair parts. High priority repair parts probably will be transferred by air, while low priority materiel is traditionally carried by the T-AFS, or in limited quantities by the AOE. AOEs have smaller capacity to carry low priority materiel.

## Competing Demands

The most readily apparent competing priority for repair parts is the aircraft flying off the aircraft carriers, the LHAs, and the LHDs. Aircraft traditionally require considerably more maintenance per hour of operation than a surface craft. This is due to the extreme nature of failure. If a ships turbine breaks down, the ship will not sink. If an aircraft engine fails, the plane probably will crash. In addition, aircraft are subjected to higher stress levels than surface craft through demanding maneuvers and the danger of being struck by foreign objects such as birds. As a result, aircraft repair parts demand is much higher per operating hour than for other craft. As deployments continue, operating hours increase, maintenance increases, and repair parts demand increases. However, aircraft components are generally smaller than surface ship components. In sum, aircraft will require increasing demand, but the individual parts can more easily be transported and more can be carried in a single load.

Another area of concern is the competing demands of the other services and potentially the other nations operating in the area. The other services will put a tremendous demand on airlift assets. However, the Navy has its own dedicated fleet of auxiliary ships used exclusively to provide support to Navy and Marine Corps operations.

The MSC uses different assets to support the Air Force and Army. The Army seems to face the most significant shortage of surface transportation assets because they have to move a huge number of vehicles. The Navy does not appear to have a shortage of surface transportation assets for repair parts, although problems may exist for delivering enough fuel and ammunition to the theater. Airlift, however, provides the greatest challenge to materiel distribution.

The Joint Logistics Over the Shore (JLOTS) doctrine also competes with the Navy's use of lift assets. However, the Navy possesses its own dedicated surface transportation, so the primary competition is for port space and airlift. Port capacity is regulated by the infrastructure around the port and its physical characteristics. These are dependent on the theater and its development. Airlift is explained in the next paragraph.

The U.S. Transportation Command (USTC) has acknowledged a shortage of airlift assets and port congestion problems when real world contingencies are occurring.[6] The Air Force is working to increase the capacities of their ports, and have instituted a program to obtain a reserve fleet of aircraft from the civilian community to provide increased capabilities in case of emergency. Currently, however, USTC can maintain two main channels for deployed carrier battle groups and amphibious ready groups. They maintain about 50 frequency channels to service requirements for all services. Some areas covered for the Navy are the Caribbean, Italy, Guam, Crete, Iceland, Hawaii, and various locations in Japan.[7] These limitations affect the movement of high priority repair parts directly. This is also directly linked to the location of the conflict, which will be discussed in the next section.

## Location Requirements and Capabilities

Regional conflicts can occur throughout the world. The Navy is required to respond anywhere in the world to meet *National Military Strategy* goals. However, different areas will present different challenges. There are several well-developed regions where support challenges are reduced compared to more remote areas. These regions include the Mediterranean Sea, most of Western Europe, the Persian Gulf, Japan, Okinawa, Korean Peninsula, and the Strait of Malacca. Each of these areas already has an established major supply channel as well as other support infrastructure, such as forward logistics sites and air terminals. Other locations possess less infrastructure or hostile neighboring nations. Some have no access to them because they are in the interior of the continents.

The major supply channels established by the services are called "frequency channels"[8] and represent established airlift routes with specific known throughput capacities. They include the aircraft assigned to that route, airports, ground transportation, and material handling equipment. Currently the throughput is 21,000 tons of materiel per month for the two main frequency channels.[9] These channels can be expanded by more efficient use of the ports of embarkation and debarkation. "Requirements channels"[10] are established when a service requests them based on the volume of cargo. In a MTW scenario, the USTC would establish a frequency channel to the theater, or to the closest logical air head to the theater. Then, the services would request requirements channels to supplement the primary channel. To better describe potential situations affecting distribution, it is necessary to compare distances from frequency channels and how distance affects distribution. Developed theaters are near main frequency channel nodes, and undeveloped theaters are more than 1,000 miles from a frequency channel node, the range of a C-2A. The main frequency channel nodes for the Navy are displayed in figure 4, while NAVICP Mechanicsburg and the FISC locations are shown in figure 5. NAVICP and the FISCs are the largest concentrations of repair parts, although material can be delivered from anywhere in the U.S. to Norfolk or Travis Air Force Base to enter the frequency channels.

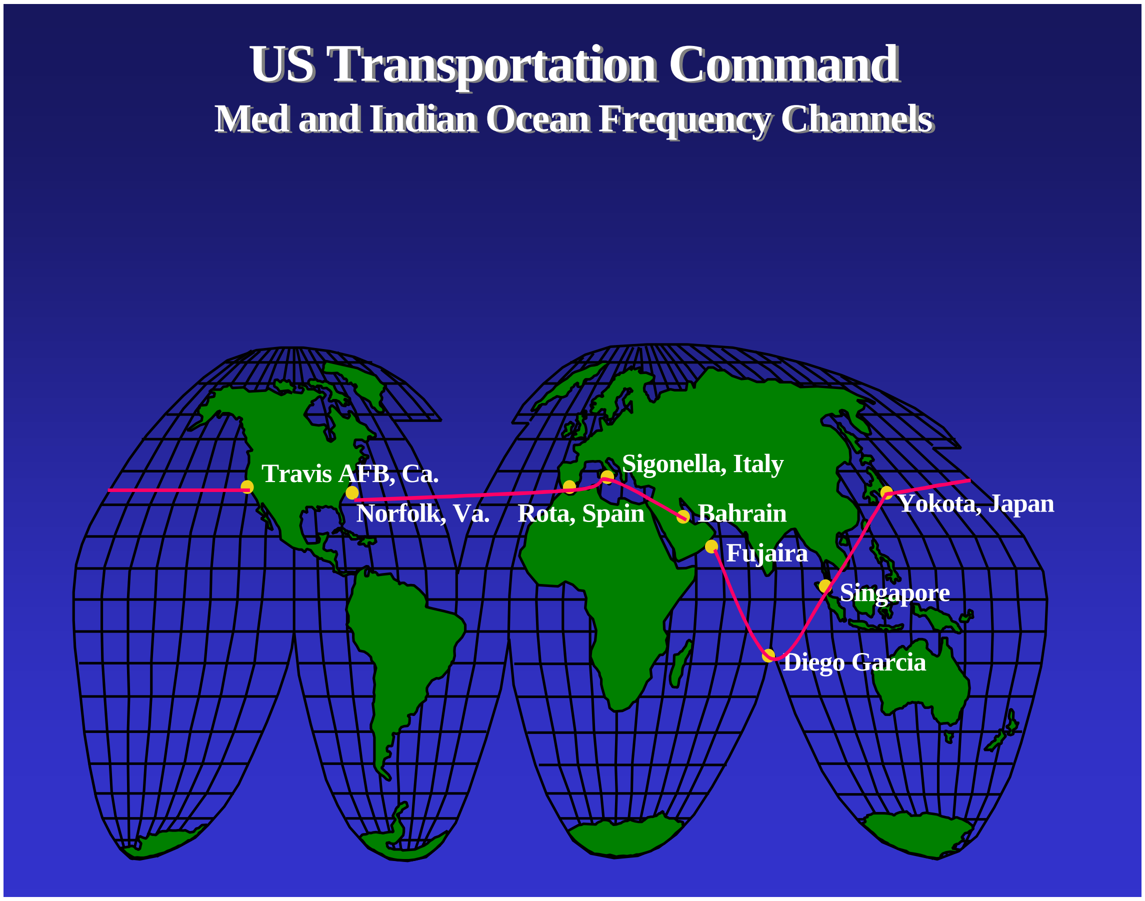



Fig. 4 Mediterranean and Indian Ocean Frequency Channels. Source: LCDR Steven Smith, "Joint Operations in Transportation: Moving Cargo and Passengers for the Navy and DoD," *The Navy Supply Corps Newsletter*, November/December 2000, 15.


Fig. 5 NAVICP Mechanicsburg and FISC Locations. Source: Linda Hall, "Naval Supply Systems Command Fleet and Industrial Supply Center Locations," electronic slide, 24 April 2001.

Developed Theaters

The two best-developed theaters where the U.S. is most likely to engage in a MTW are Korea and the Persian Gulf. The routes of resupply are well established, and political arrangements have been made to ensure the Navy's ability to conduct operations with the fewest restrictions. Throughput is documented, as are the requirements of each of the services. The most likely scenarios have been planned in advance and contingency plans have been created. These documents usually are not detailed enough to conduct actual operations, but they do provide the foundation for future planning. These plans traditionally are adapted readily to meet specific scenarios as they develop. For example, in “Operation Just Cause” in 1989, General Thurman modified prior plans for the defense of the Panama Canal to a plan to paralyze the Panamanian government completely and capture Manuel Noriega.[11] Although these adaptations may not be easy, many of the logistics problems already have been documented.

Developed theaters also possess contingency forward logistics sites with supporting infrastructure. These sites normally are operated at reduced capacity to maintain the infrastructure, until a need arises to increase capacity. They usually include the air facilities, material handling equipment, and communications facilities necessary to handle large quantities of materiel. Restrictions include runway capacity, aprons, communications, maintenance facilities, and material handling equipment. These restrictions limit the volume of air traffic that can be handled through that port. For example, the Hurghada forward logistics site in Egypt has a runway capacity to handle a C-5 Galaxy[12] transport aircraft, but its throughput is limited by lack of material handling equipment, maintenance facilities and communications equipment. A description of the aircraft’s mission is available in Appendix A and a picture is available in Appendix B. However, by flying additional equipment and personnel in on the initial flights, the capacity of these facilities can readily be expanded. Some of these sites are located near seaports, road networks and railheads to provide additional capability to change modes of transportation.

If an MTW erupts in a developed theater, the U.S. should know about it before the crisis occurs. As it develops, planning will occur concurrently, working out the logistic problems prior to hostilities. Although this has not always been the case, for instance during Iraq's invasion of Kuwait in 1990, the U.S. system of Commanders in Chief (CINC) is supposed to meet these informational and planning challenges. Generally, the U.S. appears to be surprised by contingencies when there is a lack of necessary intelligence or difficulty in properly interpreting the intelligence available. Also, lack of political will to commit large forces early affect the ability to plan. Without intelligence to suggest the beginning of a crisis is occurring that may develop into a major theater war, and the political will to act on the intelligence decisively, the CINCs cannot properly plan for the crisis. By definition, lack of knowledge of a crisis cannot be planned for, so discussing planning for crises that probably will not happen appears to be a waste of resources. The final analysis of developed theaters suggests the U.S. will know most of the requirements and the assets available to meet those requirements prior to hostilities. Shortfalls will be recognized and actions will be taken to mitigate them. Therefore, it is likely that problems in these theaters primarily will come from being overwhelmed by the opposing force or errors in the planning phase. If the requirements are for more than can be moved into the theater in time, the U.S. would remain defensive until supplies are built up, returning to the old system of just-in-case logistics, as in the Gulf War. If errors in planning occur, JIT logistics may provide an increased measure of flexibility, as discussed later in this chapter.

## Undeveloped Theaters

Undeveloped theaters are areas in which routine transportation routes are not established. Although planning may have occurred for contingencies in these areas, without transportation routes already operating, it is far more difficult to determine required capacities. The services probably will request the USTC to immediately establish or expand frequency channels and additional requirements channels to move materiel. This presents problems discussed later in this section. It is also possible no significant planning for logistics has occurred for a MTW in a particular region. This would be because these regions do not have the same strategic priority as the areas near developed theaters. Therefore, they are less likely to receive intelligence assets, and more likely to lack detailed plans. Several undeveloped areas that could cause the U.S. difficulty include southern and western Africa, central Asia, Australia, the Pacific Rim south of Taiwan, and southern Asia from India east to the Pacific Rim excluding the region near Singapore.

### Establishing New Frequency Channels

Establishing a main frequency channel probably will mean eliminating another main channel, since the Air Mobility Command (AMC) is working at capacity now. Although the Air Force has a ready reserve fleet of commercial airliners that can be activated in an emergency, they do not have personnel and equipment to manage an additional frequency channel. These include insufficient ground personnel to maintain the aircraft, material handlers, vehicle operators, and, more importantly, the infrastructure to manage three main frequency channels. When an old frequency channel is reduced, the previously supported regions will request requirements channels and become more self-sufficient. The new main frequency channel will require a considerable amount of time to build up infrastructure, such as material handling equipment, apron space, storage and transfer locations, repair facilities, and messing and berthing facilities. It also will require the tracking equipment discussed later in this chapter. Most of the equipment will come from the previous channel, but some will have to be built or rented, for instance messing facilities and warehouses.

Regional Requirements in Undeveloped Theaters

Conflict in central Asia provides a unique challenge to the U.S. There is no waterborne access to move repair parts, much less warships. Aircraft may deploy from forward bases, but not from aircraft carriers. The Marine Corps would be under the control of the ground component commander and deploy like the Army. It is unlikely the surface Navy would play a significant role in this region. The surface Navy merely would shuttle materiel and supplies to a seaport of debarkation (SPOD) for ground transfer to the theater. If a conflict occurred on the waters of the Caspian Sea in central Asia, it is unlikely the U.S. would be able to influence events at all on the water.

Other areas provide their own challenges. Where there are quality seaports and airports, many difficulties posed by operating in an undeveloped theater can be overcome rapidly through negotiation with the countries in the area and through contracts with local companies for services required. Either the U.S. already possesses forward bases in some of the areas mentioned above, or there are friendly countries in the region willing to establish forward logistic sites for the U.S. Presumably, agreements with neighboring countries would be the first priority in the planning process.

If the U.S. cannot locate a friendly nation with adequate sea- and air-ports in the undeveloped theater, new problems arise. The distance from the major logistic site to the

MTW ideally would be about 500 miles, the range of the CH-53D, to provide shuttle service for the amphibious ready groups. If further, the amphibious ready group ships would have to rely on carrier battle groups to provide the shipment of the highest priority materiel by carrier onboard delivery (COD). Diego Garcia, Singapore, and Guam may play significant roles in transportation management if an MTW occurs on the Pacific Rim or in the Indian Ocean. If distances are more than 1,000 miles, the alternatives are to leave station and move closer to the logistic site or wait for the repair parts to be delivered by surface ship. If the logistic site were close to 1,000 miles from the MTW, the range of the C-2A, then carrier battle groups would also be required to leave station to receive COD deliveries. Although this may seem restrictive to Navy operations, most Navy vessels can travel up to 30 knots in transit, requiring 24 hours to cover 700 miles, as is stated in the Marine Corps concept *Operational Maneuver From The Sea*. However, because of high fuel consumption at these speeds, it is more likely transits would be conducted between 15 and 25 knots, covering about 500 miles in 24 hours. Therefore, in two days a battle group can displace 500 miles and return to station. This would be required only if the repair parts were absolutely critical to the mission of the ship.

Rotating battle groups and establishing ships' stations up to 200 miles off the enemy's coast can mitigate the effect of air transportation ranges on operations. To conduct refueling or re-supply of ammunition, ships will be required to leave station about once a week. This process requires at least three hours to position the ships, conduct the transfer, and return to station. This will allow the ships an opportunity to receive repair parts from COD and from the supply ships. The T-AFSs carry most of the additional repair parts for the battle group and the amphibious ready group, while the

AOE carries some. The T-AKE, which displaces over 35,000 tons, will carry repair parts, ammunition, food, consumables, and a limited amount of fuel when it enters the fleet in this decade. It will replace the T-AFS and T-AE classes of ships. The re-supply ships will receive their cargo either from a shuttle ship or from the logistic sites. During transfers of bulk cargo, like fuel, food and ammunition, repair parts can also be transferred. Using surface transportation, repair parts delivery could be delayed up to seven days, the average number of days between replenishments at sea (RAS). The Fifth, Sixth, and Seventh Fleets set policy for the average number of days between underway replenishments. But, the actual conduct of replenishment is dependent on the situation of the ships involved and other priorities. If the ships requiring replenishment are conducting operations on the seventh day, the replenishment will occur before or after the operation. Similarly, if the replenishment ships are required in another location for a higher priority, the replenishment will occur when the ship returns. However, by synchronizing surface transportation with airlift assets, port congestion could be reduced or avoided. Also, in a typical operation one or more ships are transiting between the theater and the logistic site for various reasons, including completion of mission, arriving for mission, and repairs. During transit, an ad hoc transportation pipeline can be used to transport repair parts to the battle group or amphibious ready group.

## Air Transportation

Air head operations involve the movement of materiel, usually of high priority, from one location at the airport to another location at the airport and placing it on an aircraft or ground transportation for further transport. When an aircraft arrives at an airport, it must first get clearance to land, a place on the runway apron to park, and material handling equipment to unload its cargo.  For a truck or train, they require a loading dock or material handling equipment.  Once the materiel is unloaded, then it is transferred to a truck either to take it to another airplane, a warehouse for temporary storage and segregation, or to another truck or train.  Each time the materiel is loaded or unloaded from a mode of transportation, it requires material handling equipment such as a forklift or pallet conveyor.  Since assets and space are limited at an airport, the material handling equipment may not be available at the time of arrival for some of the incoming aircraft or ground transportation assets.  This causes delays in the movement of materiel. Also, one mode of transportation may not arrive at the airport when its cargo arrives. Then the materiel has to be placed in storage until it is able to continue on the next segment of its journey.  This also causes delays in materiel shipment.  Last, some of the pallets arriving at an airport may need to be taken apart to identify the materiel in it or because the materiel may be going to different destinations.  In this case, the pallet with the materiel will be sent to a warehouse where personnel will sort through the individual items on the pallet to determine its correct destination.  Sometimes pallets or individual items get misplaced in the warehouse or its final destination cannot be identified.  These pallets or individual items are called “frustrated material.”

Experiments are being conducted now to increase throughput through frequency channels without having to increase aircraft.  The primary restriction on throughput has been lift assets and port congestion.  In these experiments, synchronizing ground transportation, material handling equipment, and airlift assets can relieve much of the port congestion problems without having to increase the number of aircraft.[13]  This is called the Military Air Lines of Communication (MILALOC) program, and is one of two initiatives by the AMC to improve conditions at air heads. The initial results of the MILALOC program suggest a decrease in materiel transit time from aerial ports of embarkation (APOE) to aerial ports of debarkation (APOD) by over 3.3 days.[14] The other program is called Advanced Shipping Notice (ASN). APOEs will be notified prior to cargo arriving, so the MILALOC program can synchronize the transportation and loading segments before the materiel arrives at the APOE. These two programs may well relieve most of the port congestion. Despite these factors, supporting an MTW in an undeveloped theater could result in a net increase in transportation times.

One of the results of port congestion is loss of visibility of items moving through the port. Through in-transit visibility (ITV) initiatives, the DOD hopes to eliminate this problem by being able to identify all items in all locations in the transportation system accurately. This is a difficult task because there are many requirements to be met to complete this initiative. The first requirement is to label all materiel entering the transportation system so they can be readily identified. Bar codes are used for many repair parts, but there still are some from commercial sources not bar coded with all the necessary information. The JIT process strongly encourages the use of standard marking systems so materiel can be identified easily and does not get lost in transit. Other methods of tracking shipments are being developed, such as placing tags with a GPS transponder on large items or pallets of consolidated items, so the materiel can be located at any time or place around the world.

The next step in tracking materiel is to identify when it changes modes of transportation. This is linked directly to markings and their ease of use. For example, during the Gulf War materiel was arriving at sea and air heads but the it was being misplaced when pallets were broken down or entire pallets were misplaced because of the volume of materiel arriving and difficulty in identifying the materiel. Bar codes work as long as every point in the transportation system has the equipment to scan them, and the material handlers are trained on the scanners use and importance. This problem can be reduced by standardization across the transportation industry. If the same method of labeling and tracking materiel is used, and one database is maintained for this information, tracking materiel will be less complex and more reliable. This system already exists in the military and its civilian shipping companies, and functions fairly well. However, none of the systems are interconnected, so the supply officer on the requiring ship has to go through several steps, depending on which company is shipping the materiel, before he can locate it.

The Army is applying another technology called the palletized loading system (PLS) to reduce congestion through the entire logistics system. The Army intends to load its ammunition in pre-configured pallets from the factory to meet the requirements of the using unit. By pre-configuring pallets, there will be no need to break them down in transit to reconfigure them, no excess material, and no additional delays. It also reduces the number of stops particular pallets have to make. The materiel can be loaded for shipment directly to the using unit and does not have to go to any intermediate points. This reduces the number of staging areas and personnel required. If PLS could be applied to other items in other locations, the benefits across the system become significant. This could include configuring pallets with repair parts specific to particular battle groups for the operation they are conducting. These pallets could be transferred by auxiliary ship to the battle group on station.

The last problem in tracking repair parts is integration of the various systems. Different systems track arrival, departure, and cancellation of flights, and these do not interface. This obviously causes more confusion and a lack of trust in the transportation system. With integration of the various systems, reliability and consequently trust in the transportation system will increase. This problem has been acknowledged by each of the services and each is attempting to integrate their systems to create a single database with all required information. The first program attempting this is the in-transit visibility or ITV program as previously discussed. It is also being integrated with the JTAV program, addressed in *Joint Vision 2020*. These are in various stages of implementation across the DOD, but results are being seen now. When high priority repair parts are ordered, searches are conducted throughout the entire DOD and GSA to locate the materiel wherever it may be. Once shipped, it can be tracked most of the way through the transportation system. The eventual intention is to have a "one-touch supply" system that a unit can log onto anywhere in the world and get real time information on the location of parts and the status of materiel in transit.[15]

## Just-In-Time Inventory and Distribution Characteristics

By maintaining inventories at smaller levels, as professed in JIT logistics, several factors must be considered. JIT logistics stems from the manufacturing sector of private industry, and the differences require analysis and comparison with military requirements and capabilities. The goals of JIT manufacturing are unique. JIT manufacturing techniques were designed and implemented in industry for quality improvement purposes. Results of implementation in civilian industry require review. The effects of reducing Navy repair parts inventories, as prescribed in JIT manufacturing techniques, must be determined to measure its effect on the requirements in the *National Military Strategy*. Each of these areas will be examined in this section of this chapter.

## Just-In-Time Manufacturing Techniques

In the quotation "Just-in-time production exposes problems otherwise hidden by excess inventories and staff,"[16] Mr. Schonberger explained the essence of JIT production goals. In private industry the primary purpose of implementing JIT manufacturing techniques, to include JIT logistics, was to increase productivity and quality. As explained in chapter 2, the underlying tenet is that by not having a buffer of inventory, a worker receiving a defective component to install in an assembly would be forced to halt production and notify management to get a good component. By doing this, defective components could be recognized readily and problems corrected before any defective assemblies were produced. This increased the quality of production. The primary purpose of not having an inventory was to make apparent any defects in materials.[17]

Another important aspect of JIT manufacturing techniques was increase in flexibility of the production line. If an order came into a factory for model B instead of model A, the plant could rapidly convert to making the new model quickly and with less scrap material. Without inventory, there would be less waste, since there would be few components for model A in the manufacturing plant or in the shipping pipeline. The suppliers, if they used JIT manufacturing techniques, could also change rapidly to supplying components for model B.  If current suppliers did not make components for model B, the company could just write another contract for the new components.  The company would not be tied to a large inventory of materiel and its associated cost.

One of the requirements for this flexibility was the use of small, multipurpose manufacturing equipment vice large, cumbersome equipment.  The small equipment permitted rapid reconfiguration of the plant to allow production of new models.  Ideally, JIT manufacturing would push a company to use equipment that could be reconfigured in a few minutes.  This differed from typical American manufacturing techniques of the time, which professed using large equipment and mobilizing for long production runs. Setup costs were assumed to be constant, whereas the JIT model encouraged the reduction of setup costs to near zero, and time to reconfigure to a few minutes.  As industry adopted JIT plant configurations, companies were able to realize flexibility beyond that offered by American manufacturing techniques of the time.

Note that all the manufacturing techniques above do not apply to the military or surface Navy ships, since the military does not manufacture material items.  The military has no assembly lines to be coordinated, arranged, tracked, or flexed.  The surface Navy, in particular, is almost exclusively an end user, meaning products provided to the Navy do not get passed to anyone else.  The Navy provides deterrence and defense services only, without producing any actual items.

In addition to plant configurations and low inventories, JIT manufacturing techniques also encouraged the use of dedicated transportation.  Covered later in this chapter will be requirements for suppliers to deliver the materiel to the user, called free onboard (FOB) destination.  However, if the supplier could not deliver FOB destination, the company was encouraged to use dedicated transportation instead of bulk carriers. The idea was to avoid having materiel sit in a location waiting for a full truckload. If a company used bulk transportation, it did not have direct control over when materiel was shipped, losing flexibility. However, if the company did possess its own transportation fleet, it could direct it to deliver items as priorities dictated. The size and type of vehicles in the transportation fleet were dependent on the location of the suppliers.

## Results of Applying Just-In-Time Inventory Techniques in Industry

Using JIT inventory techniques could increase a company's quality output by ensuring greater diligence by workers in the manufacturing process. Having small inventories also allowed greater flexibility by not having to dispose of old inventory. This was especially important in high technology industries, where an item could become obsolescent in a few months. Such companies could not afford to maintain stockpiles of inventory because they would not be flexible enough to meet the changing market.

Two more aspects of JIT inventory management require further discussion. They are a flexible transportation system and, through use of small inventories, reduced scrap and disposal costs. JIT inventory management requires a transportation system that allows flexibility and reduces delays caused by receipt of defective materiel. However, the increased demand on transportation is not necessarily as bad as it may seem. Since there is no buffer of inventory, it is crucial to know where every asset is and when it will be delivered. This requires the supplier to make deliveries every day on time, in exact quantities, directly to the assembly line. To accomplish this, proper labeling of materiel and a good tracking system are essential. If materiel is not easily identifiable, it may get lost when received, or require a delay for additional inspection. Neither of these is tolerated when the company needs the item immediately. If labeling is correct and tracking is accurate, management knows what components are arriving every day: the exact quantities, times, and locations. This is similar to ITV and TAV. Management can then contact their suppliers with very short notice to stop shipment of components no longer required. A secondary benefit is the flexibility to divert transportation assets to provide support where required. If a company knows that a truck is loading at supplier A, and supplier B is preparing to meet a new requirement, the truck can be diverted to supplier B before making deliveries to the plant. In addition, by knowing where and how much materiel is in transit, the company knows when to stop ordering for a certain production run so money is not wasted buying components not required or transporting materiel no longer needed. The net result industry has been a minor increase in transportation requirements, with substantially increased flexibility of the transportation system.

By maintaining a small inventory or none at all, a company saves the cost of buying the inventory and later of disposing of any excess. Scrap is a routine factor in a manufacturing process, resulting in about 4 percent of materiel costs. It consists of waste generated in manufacturing, defective materiel, and excess inventory that requires disposal.[18] By not having excess inventory scrap costs are reduced and defective materiel is identified immediately for the supplier to replace. This leaves only scrap costs resulting from the actual manufacturing processes. The savings can be significant, especially if the company routinely deals in perishable items that have a short shelf life. Scrap costs do not apply to the military since the organization does not produce material items. However, reducing waste does apply to the military. Repair parts held in inventory that never get used eventually become waste and must be disposed of.

The most obvious effect of reducing inventories is the reduction in cost to maintain the inventory. Industry has seen drastic reductions in cost of overhead due to reduced or nearly eliminated inventories, despite small increases in transportation costs. Another benefit of reducing inventories has been the reduction in inventory management and warehouse requirements. The total of these effects compares favorably to the small increase in transportation costs. This reduction in inventory can be applied to the military, and is the most common aspect of JIT characteristics discussed. The application of reduced inventories to surface Navy repair parts will be reviewed in the last section of this chapter, providing the framework for chapter 5.

## Just-In-Time Purchasing Characteristics

JIT purchasing contributes to the flexibility of the manufacturing process. It possesses unique characteristics that differ from the government methods of contracting and acquisition. However, many ideas have been taken from JIT purchasing to improve government contracting and provide increased flexibility in contracts. While reviewing Japanese purchasing practices, Mr. Schonberger wrote, "Purchased inventories are considered as evil as in-plant inventories. Therefore, the JIT concept as applied to purchasing translates into frequent releases or authorizations and frequent deliveries."[19] The fundamental principle of JIT purchasing is to acquire supplies in small lots, deliver them as frequently as possible, and order them only when needed.

## Just-In-Time Supplier Characteristics

For JIT purchasing to work, the biggest requirement on a contractor is reliability. Accordingly, JIT purchasing offices are staffed differently than standard purchasing offices. Also, goals are substantially different. To gather the best suppliers, selection is not based on price; it is based on who currently has the contract. Unlike the federal acquisition system, which requires the use of full and open competition to the maximum extent possible,[20] JIT purchasing attempts to keep the same supplier for the longest period possible. To accomplish this, the supplier is assisted in setting up his business to meet the company's requirements. He is provided assistance in meeting the specifications of the contract, reducing his delivery lot sizes, meeting delivery schedules, and using JIT practices so he can apply them to his suppliers. The buyers have a close relationship with the suppliers, as do the quality control personnel of the company. The quality control personnel focus on process control instead of inspection to achieve long-lasting results. All the assistance is to make the supplier more competitive and to continue to provide the supplies in accordance with the contract. The process of helping the supplier to make him more competitive is contrary to government regulations, which require all information to be provided equally to all competitors.

A supplier is encouraged to locate close to its customer company to reduce shipping times and supplies in transit. Suppliers are encouraged to reduce their lot sizes to the minimum necessary. The purpose of this is so the company holds no materiel in stock. This is accomplished by scheduling multiple deliveries from the supplier weekly or even daily. If the supplier is located close to the company, deliveries could be made hourly in very small lot sizes. No variation is permitted between requested quantities and deliveries. To accomplish this, suppliers are required to provide steady output. This method of steady output and minimal lot sizes with multiple deliveries per day makes the supplier appear more like an extension of the company than a separate organization. This is because integration is encouraged throughout the process. JIT supplier characteristics applied to purchasing repair parts for the Navy will be analyzed in the last three sections of this chapter to provide the framework for chapter 5. Its effect on the surface Navy's ability to conduct two nearly simultaneous major theater wars will be answered in depth in chapter 5.

## Just-In-Time Contract Characteristics

JIT contract characteristics are designed to provide suppliers for the longest possible period, with the least amount of paperwork and restrictions. According to JIT purchasing, the ideal supplier is the one that is loyal to the company and lasts indefinitely. As discussed above, once a supplier gets a contract, the company using JIT purchasing practices provides a great deal of assistance to help that supplier have a significant advantage over its competition, further increasing the likelihood the supplier will remain loyal to its customer.

As might be expected, companies using JIT purchasing try to reduce the suppliers to the smallest number possible. It requires less infrastructure to establish and maintain one contract than three or four. Government contract laws require consolidation of like requirements to reduce contract costs. Therefore, the government is already attempting to reduce the number of contracts by consolidating requirements. However, under government regulations, when substantial cost savings can be achieved, multiple requirements may be broken into logical pieces and distributed among several suppliers. This does not support JIT purchasing, since it generates no loyalty to any particular supplier. Another method of reducing the number of suppliers is to restrict competition. This also goes against government regulations, which encourage as much competition as possible to get the best product or service at the best price. With competition, however, comes a lack of loyalty to any one supplier and the supplier in turn lacks loyalty to the government.

Arrangement of a JIT purchasing department is different than in a standard purchasing department. There are few buyers, since there are few contracts and the buyers have been doing business with the same select group of suppliers for some time. In addition, the transportation section is part of the purchasing department. This allows transportation arrangements to be made as orders are placed. Although buyers attempt to negotiate contracts with FOB destination as one of the clauses, some suppliers may not be able to deliver the materiel. If so, the transportation section of purchasing can arrange for its own transportation assets or for contractor transportation dedicated exclusively to the company, to provide pickup and delivery at times and locations convenient to the company. To help make this more efficient for distant suppliers, buyers will try to contract with several suppliers located in the same area. Transportation can then arrange for pickup from this “cluster” of suppliers and combine shipments.

Types of contracts can also help maintain a particular supplier base. A JIT purchasing office would rely primarily on long-term contracts with few suppliers. Long-term contracts provide the supplier the security and incentive to invest the time and effort necessary to meet all the requirements of the company. However, since deliveries may vary from day to day, but the contract is long term, the contract would need certain flexibility. It would have to have a fixed total delivery over a long term to provide the supplier with security, and with a method to request delivery as needed to meet demand as it fluctuates. This type of contract is called a blanket purchase agreement (BPA) in civilian industry.

In government, a BPA is not considered a contract, but a governmental parallel does exist, called an indefinite delivery or requirements contract. The basic aspects of an indefinite delivery contract are that the government agrees to buy a certain amount of materiel from a supplier, but it does not specify when the materiel is required. There is no specific delivery date or time. Instead, there is an established procedure for placing a delivery order when the materiel is required. In JIT purchasing, delivery order placement is encouraged to occur at least daily, if possible, to maintain a steady flow of materiel into the manufacturing plant. In addition, to keep the process streamlined, there should be minimal release paperwork for placing a delivery order, and for receiving the materiel. By minimizing paperwork, the cost of the contract is further reduced. The military does use indefinite delivery contracts when appropriate, and delivery orders do not require much additional paperwork. Therefore, this process works well with contracting requirements for the government and industry.

Another characteristic of JIT purchasing contracts is the method of describing requirements. In standard contracts, requirements are routinely described by their physical characteristics such as dimensions, or by name brand such as “Craftsman quality tools.” JIT style contracts have minimal specifications and avoid describing physical characteristics. Instead, they describe performance characteristics, or what they want the product to do. This allows the supplier to innovate on how best to meet the requirements of the contract. The DOD and the Navy have embraced this idea fully. The request for proposals for the interim brigade combat vehicle and DD 21 used performance specifications instead of design specifications. This was the first use of this type of contract to procure ships of this size. This method reduced the time to award the contract because the government did not have to write design specifications for every piece of equipment. Companies submitting proposals were allowed to design this ship to meet the government's performance requirements at the lowest cost. Examples of performance requirements for this contract included speed, crew size, and type of missiles it must be able to launch. Using design specifications, the request for proposals told industry how to construct the ship from engine room location to the size of the type of toilets to use. However, by not providing design specifications, the contractor assumes the responsibility and the risk in designing the item to meet the requirements of the contract. This requires the company, in this case the Navy, to put more trust in the contractor than before.

A final characteristic of JIT logistics helps ensure mutual trust between the supplier and a company. The company must resist producing the supplies it needs instead of buying them from another supplier. If the company starts to integrate vertically to save money, supplier loyalty will drop and the suppliers will have to diversify and establish contracts with other companies to ensure survival. When suppliers build contracts with other companies, the interdependence between supplier and company is eroded due to the demands of more customers. The current trend in government contracting is to outsource as much as possible. Therefore, suppliers face less risk of being driven out of the market by its own customer.

## Benefits of the Just-In-Time Purchasing System

JIT purchasing systems allow a company to rely on suppliers to deliver their materiel on time, so it needs to maintain almost no inventory. Because of significantly reduced inventory, the entire contracting process is more flexible and can respond to changing orders rapidly without waste. Since the suppliers are located near the company, travel time and costs are small. The Navy is able to take advantage of similar flexibility during routine non-battle conditions. However, because the Navy is global in nature and its users move, collocating the suppliers with buyers is difficult to achieve. During two major theater wars, oceans will separate the Navy and its suppliers, so collocating the suppliers with buyers in the theater is unlikely.

Because the contracts are long term, the cost of materiel is reduced because of volume discounts and the learning curve applied to the creation of contracts. Initially, a supplier's cost of making a part or setting up transportation systems to deliver it is high. After time, the cost goes down as the supplier learns the system and innovates to reduce costs. Because of frequent deliveries of small lots, detection of defects occurs almost immediately. This allows reducing scrap costs and bringing about increased quality over the long term. The Navy can take some advantage of long-term contracts, but government contract law limits it. The Navy must maintain full and open competition and cannot provide preferential treatment to any one contractor, no matter how well he is at meeting Navy requirements. Because of long-term contracts and a mutual dependence between the supplier and the company, there is less need for inspection. Instead, the supplier and the company send their engineers and quality control personnel to each other's plants to observe the processes and recommend improvements.[21] With JIT purchasing techniques, the emphasis is on process control instead of inspection. Again, government contract law requires certain inspections of materiel be conducted, as well as separation of functions.[22] Therefore, although inspections can be reduced, they cannot be eliminated, and the contractor-buyer relationship can never achieve complete trust.

To maintain a long-term contract, the supplier will take risks to keep that contract. Mr. Schonberger said, "A supplier selling, say, 60 percent of its output to a single buying company will go to great lengths to be responsive."[23] He will design his production to meet the demands of his primary customer, and become dependent on that customer. The supplier will realize if he loses the contract with the company, he will probably go out of business. This is a big incentive to make sure the company gets what they want. This has already happened throughout the defense industry. Electric Boat Corporation and Lockheed-Martin Corporation will go to great lengths to ensure they keep their current share of the defense market. Each of the surviving defense contractors today is extremely dependent on government contracts. However, they have an additional method to ensure their survival outside of the contracting arena. Many times, contractors used their political influence to obtain favorable positions in contracts, and they will continue to work in this fashion as long as it is allowed.

Life-cycle management contracts are one of the methods the Navy ensures the supplier provides the best product and service over the life of the equipment. These contracts are written so the contractor provides the particular piece of equipment, along with the repair parts and the depot level maintenance and repair services. They provide the contractor additional profit if the equipment requires fewer repairs during its life cycle than government predictions. Also, by assigning the life cycle responsibilities to the contractor, the Navy does not need to stock the repair parts; This is the responsibility of the contractor.

The design and goals of JIT purchasing methods encourage large, long-term contracts with a few suppliers. This means the staff in the contracting office can be reduced because they negotiate with only a few suppliers and contracts are negotiated less frequently. The Navy seeks large long-term contracts, but cannot limit the number of suppliers. Government contract law does not allow preferential treatment of the incumbent contractor. In addition, commercial items must be purchased primarily based on the price, in order to ensure competition.[24]

The design of contracts using JIT purchasing techniques also allows less release paperwork and less expediting, but government processes hinder full implementation in the Navy. With JIT purchasing techniques it is routine to call in orders the day they are required. There is simple accounting for receipts since there are only a few suppliers and labeling is consistent. In comparison, governmental procedures tend to burden the reduction in paperwork, but efforts have been made to reduce this effect. The best example is use of the government purchase card, where little paperwork is required. In addition, the DOD and the Navy are pursuing paperless contracting, where all information is passed electronically. Some organizations in the Navy are able to do business this way now. Naval Regional Contracting Center in Philadelphia has instituted a paperless contracting office. Currently, it is easy to place delivery orders against a contract already established.

Various socioeconomic programs designed to aid disadvantaged businesses also hinder implementation of JIT purchasing techniques. These socioeconomic policies, while providing aid to many businesses that are disadvantaged in some way, do not always provide the government with the best or most reliable supplier. Many small businesses have to subcontract out a significant portion of the work to accomplish the contract. This adds an additional layer of cost and control for the government.

## Capabilities with Just-In-Time Practices Versus Requirements

JIT inventory practices can save money throughout the government, including the Navy, but certain assumptions must be made. Not all of these assumptions fit well in supplying repair parts for the surface Navy. First, the demand for the supplies must be fairly steady. Although the JIT system is designed to be flexible, it also requires long-term commitments between companies and their suppliers. The supplies must be produced in a relatively short time. If they take a long time to produce, the supplier cannot quickly change his production schedule to meet an increasing demand, or he cannot scale back his production if demand is reduced. Therefore, flexibility is lost and someone, either the contractor or the government, will have to assume the risk. Second, the government must be able to enter into long-term contracts with the supplier. Although this can apply in some situations, there are many where it cannot. Because of contract law, the government is required to purchase commercial items based primarily on price. Also, several socioeconomic programs designed to aid disadvantaged businesses restrict the government from choosing the contractor with the best possibility of providing the best service.

The Navy maintains its own local transportation as well as contracting for some of it. However, the strategic transportation system is managed as a separate entity by USTC. JIT transportation management does not seem to fit well with the nature of the military. Navy repair parts requirements are spread across the globe and they fluctuate too much to allow a separate transportation system for each purchasing department across the Navy. Also, repair parts are received from sources all over the U.S., and overseas, further complicating the use of a JIT transportation system.

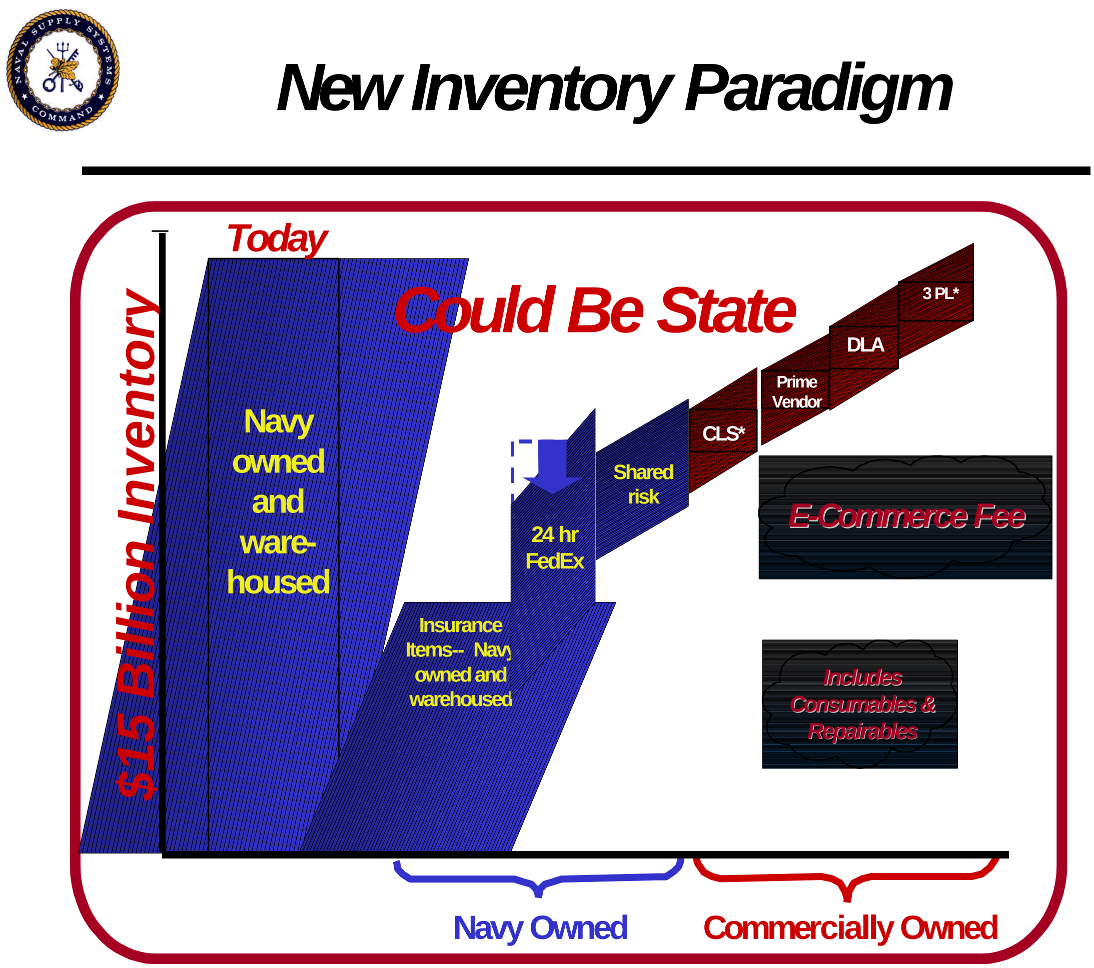
Although the JIT system may place an additional demand on airlift and surface transportation assets, certain qualifications need to be placed on this increase. Surface transportation is used primarily for medium and low priority repair parts. This includes strategic and theater assets. All high priority repair parts move by air. Each of these modes of transportation will be viewed separately.

Surface transportation assets have such a large lift capability, it is unlikely any small increase in requirements will have any significant effect on medium and low priority repair parts. Ships can carry the largest repair parts the farthest distances with plenty of room to spare for more. Therefore, an increase in demand should have no effect on medium and low priority repair parts delivery times.

On high-priority repair parts, the net requirements increase needs more detailed examination. First, the increase is not likely to be significant since JIT inventories are not applied to end use assets. Just-in-case inventories continue to be applied to ships. Therefore, if the required repair part were not in the battle group after applying the JIT system, it would not have been there before applying the JIT system. Second, the Joint Total Asset Visibility (JTAV) and in-transit visibility (ITV) initiatives will provide several benefits. The required repair part could be found quicker throughout DOD once the programs are fully integrated. The database will be able to locate the part in any storeroom in the world, including other ships, regions, DOD agencies, and contractor supply rooms. Third, and most important, is the ITV system. When fully operational, customers can tell where their parts are anywhere in the transportation system and the length of time for that part to get to them. This will increase confidence in the supply system and allow customers to place one order for repair parts. This avoids the problems of the Gulf War when customers ordered repair parts several times to ensure they actually received it.[25] This caused congestion in the transportation system, reducing its reliability.

Last is how JIT application has been applied to the Navy and DOD inventory. The Navy has restricted its application to those items that do not require long lead times to produce. The Navy owns or buys about $15 billion in materiel per year, but the repair part inventory is about $5.3 billion.[26] NAVICP manages 350,000 repair part line items. Currently, the Navy expects to apply Performance Based Logistics (PBL) to 30% of its repair parts inventory by 2005 by line item.[27] PBL is the application of JIT logistics with respect to systems, not including individual items. However, this represents the ideal in JIT logistics and the largest amount of expected savings. SUP 21, the new organization established to integrate and coordinate logistics related projects, has stated JIT logistics will be applied to only about two-thirds of the current Navy inventory, as shown in figure 6. One-third of this materiel will still be owned by the Navy but warehoused by commercial activities, leaving only one-third of the current inventory eliminated from

Navy property. Various contractors or DLA will provide that one-third, with specific delivery requirements to ensure timely delivery. The items maintained using the just-in-case logistics system will be those that require a long time to manufacture or are cheaper to warehouse than to dispose of and then buy again later.




*CLS-Contractor Logistics Support
*3PL-Third Party Logistics

Fig. 6. Source: SUP 21 Reengineering Office, “SUP 21 Reengineering Office Update,” slide 14.

## Conclusion

This chapter reviewed the requirements and capabilities for supporting two major theater wars, the concepts and application of JIT logistics for repair parts in the Navy, and some of the direct effects on the logistics system. The two areas of JIT logistics that are applicable to the Navy, the inventory and distribution of repair parts and procurement of repair parts, were also covered in depth. The characteristics and capabilities were also compared to surface Navy repair parts requirements to determine effectiveness. From this analysis, it will be possible to determine the answers to the original research question, along with the secondary questions. These questions and final answers will be reviewed in chapter 5, along with limitations created by the data collected and possible alternate research topics uncovered during the research.

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# CHAPTER 5

# CONCLUSIONS AND RECOMMENDATIONS

This chapter will provide the final conclusions derived from the research and analysis presented in the previous chapters. It will provide answers to the questions introduced in chapter 1 and provide recommendations to improve the Navy logistics system for surface ship repair parts and the DOD planning and transportation systems to support the current *National Military Strategy*. This chapter will also identify the importance of the conclusions presented and their significance to the military. It will address some of the limitations of application of this research and finally, will provide recommendations for future research and analysis.

## Conclusions

Fourteen questions were introduced in chapter 1. Although these questions were discussed in the analysis, information on each will be provided in this section to conclude the research. Answers will be provided first for the primary question, including the conditions and limitations necessary for review when addressing this question. Second, the secondary questions will be reviewed and answered. This will present ideas to improve Navy repair parts management and distribution that will be covered in the following section.

### Primary Question

The primary question for this paper is, Will the JIT logistics model be sufficient to support surface Navy repair parts requirements for two nearly simultaneous major theater wars? After reviewing the analysis and substantial research presented on this subject, the JIT logistics system will be able to support surface Navy repair parts requirements for two nearly simultaneous theater wars. However there are certain conditions and restrictions that must be considered to ensure this holds true. In each of the situations listed below, host nations can improve conditions for the Navy by providing bases or transportation and distribution. Conversely, if the U.S. has no ally, and no host nation support in the theater, this can hinder operations and repair parts distribution throughout the theater.

Primary Restriction

The primary restriction for JIT logistics to provide the necessary repair parts to the surface Navy in supporting two major theater wars is the need for capital to buy these repair parts. This is the ultimate goal of the Navy's application of JIT logistics to its supply system. Although JIT logistics is expected to save a few hundred million dollars, it will not save enough money to buy everything the Navy wants, or needs. Individual ships cost billions depending on class, and a single F/A 18 E/F aircraft can be over $35 million.[1] If JIT logistics saves $200 million, this buys less than six aircraft, not even a squadron. The Navy requires 1,000 of these planes from 1997 through 2015.[2] That is $35 million times 1,000 aircraft for a total program cost of $35 billion over 18 years for $1.9 billion per year. Therefore, the question of fleet support is reduced to how much money is appropriated to purchase the repair parts to support the fleet and less a question of type of logistics method used. However, JIT logistics does save costs over just-in-case logistics practices, and results in an ability to purchase two to five hundred million dollars worth of required repair parts, or establish a few more contracts with industry to manufacture a repair part when the need arises.

Using JIT logistics also provides the government with other secondary benefits. In a constrained fiscal environment, instead of purchasing repair parts and storing them when they may not be needed, contracts are established to purchase the repair part only when needed. This allows costs to be saved for storing additional repair parts. More importantly, it allows greater flexibility in the supply system because money is not wasted on repair parts that will never be used. Instead, it is spent only on those repair parts that are actually needed.

## Condition One

The first condition that must exist for JIT logistics to work is unrestricted access to the theater. This means the Navy must be able to bring replenishment ships into the theater without a significant chance of losing the ship due to enemy action. The theater commander will make a determination on how great the threat is and how much risk he is willing to take.

The Navy relies on underway replenishment and replenishment in port to provide required repair parts to the carrier battle groups and amphibious ready groups. Generally, Navy ships perform their missions underway, so leaving the area of operations to enter port must be restricted to times when the threat is known to be low or when operations are not currently required. This requires most replenishment to be conducted underway. If an adversary can interdict the sea lines of communication successfully with sufficient frequency, they may be able to influence the theater commanders' decision on location of his replenishment ships, causing the withdrawal of Navy assets to permit replenishment in a more benign environment. Note that interdiction can be tolerated if the theater commander is willing to accept the risk to his ships. In the Gulf War, two Navy ships sustained damage while underway. The USS TRIPOLI sustained damage from a floating mine to its aviation fuel pump room, but was able to continue its mission with refueling restrictions. The USS PRINCETON also sustained damage from a floating mine to its propulsion system and was unable to maneuver. However, the Navy cannot afford to lose a replenishment ship in a similar manner because of the limited number of assets. With only 35 assets, spread between two theaters, 25% of them undergoing overhaul, and others conducting transits, the number available to distribute repair parts is less than 13 per theater. Also, replenishment ships are not as well protected as other surface ships. AEs and AOEs carry enough ammunition to cause the loss of the entire ship and crew if the magazines are penetrated.

The theater commander will take into account the types of threat, degree of threat and the requirements for the surface Navy to decide where to locate the replenishment ships. For example in the Gulf War, the theater commander decided the threat of floating mines was too great in the northern Persian Gulf, so all replenishment ships were kept in the central and southern regions of the Persian Gulf to reduce the risk. Similar decisions will have to be made by the theater commanders in any region where the surface Navy is involved in a major theater war.

Condition Two

The next condition to support JIT logistics is the judicious application of the program to the correct repair parts. JIT logistics does not work for items that require long-lead times to manufacture when there is an increase in demand. For example, a Tomahawk cruise missile requires over six months to manufacture during peacetime. Although this manufacturing process could be sped up, it would require mobilization of certain portions of the defense industry, which also requires six months or longer. The U.S. desires to keep major theater wars as short as possible. Therefore for this item, there is no substitute for just-in-case logistics. Currently, the Navy intends to apply JIT logistics to two-thirds of its inventory.[3] This requires constant monitoring to determine which items are too critical and take too long to manufacture to permit someone else to provide. Industry will provide some guidance in this area, because as risk goes up for a supplier to provide a complex item in a short period of time, the supplier will raise the price of the item. Price analysts can match this cost to the cost of buying the repair part outright and storing it. Although this comparison provides a method of determining difficulty in manufacturing, it does not take into account the importance of the item to the systems it supports.

Condition Three

The third condition to implement JIT logistics is adequate transportation pipelines. There are four combinations to review. These are developed theaters with control of the lines of communication, developed theaters without control of the lines of communication, undeveloped theaters with control of the lines of communication, and undeveloped theaters without control of the lines of communication. These circumstances factor in the most important influences to repair parts distribution to and within the theater.

## Developed Theater With Control of the Lines of Communication

For developed theaters with control of the lines of communication, JIT logistics works the best compared to the other conditions. With frequency channels, throughput is already known, and infrastructure, as well as actual transportation assets, is established and developed. As discussed earlier, there are at least two programs to increase this throughput that could be necessary depending on the type of major theater war that develops. Sea transportation assets are adequate to meet requirements for the surface fleet since repair parts generally do not consume the majority of capacity on auxiliary ships. Food, fuel, and ammunition require more space, and fuel is required more frequently than repair parts resupply. With control of the sea lines of communication, there should be no problem providing repair parts too large to be transported by air over long distances.

## Developed Theater Without Control of the Lines of Communication

In developed theaters with restricted sea lines of communication, the surface delivery of repair parts becomes much more difficult. Also, an adversary could potentially interdict the military's air lines of communication through terrorist style acts against the military's ports of embarkation or debarkation. The CINC will increase security in the various ports, resulting in a decrease in throughput. However, he will have to weigh the costs to protect the port against the requirements of getting the materiel in. If the sea lines of communication are interdicted away from a port, ships can be rerouted, escorted, or required to face the threat directly. The situation will determine the correct action, with the CINC making the final decision in concert with the National Command Authority. The effect on the JIT logistics system will depend both on the success of the adversary in interdicting the lines of communication and the CINCs' response to the threat of interdiction. The transportation system is separate from JIT logistics. Because the transportation system does not differentiate between repair parts obtained from JIT logistics or just-in-case logistics, the effect on JIT logistics will be the same as that with just-in-case logistics.

The requirement to move materiel to the theater remains the same, but timing may change. The CINC may choose to use the just-in-case logistics method to stockpile materiel in the theater for future use. However, if he chooses to use the JIT logistics model and to rely on the rapid movement of materiel to the theater just as it is required, his dependence on the transportation system is increased. The effectiveness of the transportation system will determine which method is best suited for the conditions.

### Undeveloped Theater With Control of the Lines of Communication

In undeveloped theaters, the transportation throughput problem is more significant. The requirements channels are not known, much less their throughput. In addition, time may be required to establish a forward base with adequate seaports and airports. In some locations, the situation and terrain may require several intermediate staging bases to handle the volume of materiel required for each armed service. While establishing these bases, ports, and requirements channels, the likelihood of having a high quality tracking system in place is poor. Facilities, trained personnel, and organization are required to provide a quality transportation system, and none will be present initially. As the theater matures and materiel begins to arrive, a backlog of frustrated material will grow and repair parts will get lost in this backlog. This was a significant problem during the Gulf War. When thousands of tons of materiel were stockpiled personnel had a difficult time determining the final destination of some of the materiel.[4] However, the CINC and USTC will eventually conduct the proper planning, obtain enough facilities, trained personnel, and organization established so the requirements channel can develop into a high volume throughput pipeline with a reliable tracking system. The backlog of frustrated material will diminish as personnel and assets become available to investigate missing shipments, although all the frustrated material will probably not disappear until after the crisis has passed. The JIT logistics system will work in this situation, but it is dependent on the length of time it takes to establish a quality transportation system. Also, in this case, JIT logistics may actually reduce the problems encountered in the frustrated material buildup. Because materiel is only coming into theater as needed, it is not being stockpiled at any particular point and is quickly moved to the next available means of transportation to get the materiel to its ultimate destination.

### Undeveloped Theater Without Control of the Lines of Communication

In the final case, delivery of materiel becomes difficult and may require significant buildup time. Without control of the lines of communication and no established frequency channels or surface shipping routes, extensive planning must be conducted to determine how to proceed. There are several alternatives, ranging in risk from minimal, when the lines of communication are not significantly interdicted, to extremely hazardous, when casualties and loss of shipping or aircraft are expected. The situation will determine how to proceed. Some of the alternatives include: establishing an intermediate staging base outside the theater and conducting sea control operations prior to entering the theater; establishing air lines of communication while maintaining shipping only to an intermediate staging base outside the theater; establishing shipping to the theater without establishing air lines of communication; and proceeding into the theater with both air and shipping assets despite the risks. Design of the transportation is situation dependent. Under these conditions, the CINC will probably resort to just-in-case logistics and establish stockpiles of materiel to provide more flexibility in the theater.

### Condition Four

The last condition required is the reason for many questions on the effectiveness of the JIT logistics system to provide repair parts. The system is dependent on the willingness and ability of the suppliers to meet the demand no matter the conditions. The first requirement to meet this condition is the quality of the contract. It must be properly written, to require the supplier to provide the repair parts in a timely fashion with the applicable transportation arrangements. The second requirement is the quality of the supplier. The supplier must be trustworthy to meet the increased demand during crisis situations. This includes willingness and capability. The Navy is relying more heavily on its contractors and its contracting officers to write quality contracts and meet the requirements in those contracts.

An analogy will aid in quantifying the Navy's dependence on its suppliers. The LPD 17 program, a new type of amphibious ship, intends on contracting out the entire life cycle support system to a single group of contractors. This means, for the 35-year life cycle of the new amphibious ship, the Navy will rely on a small group of contractors to provide all the repair parts for the ship.[5] The Navy will maintain some long lead-time repair parts, but the contractor will provide the majority of smaller parts. Currently ship support has not been so thoroughly transferred to contractors. The Navy has only begun to implement transfer of supply responsibility to contractors. Reliance on contractors will increase as older ships are decommissioned and newer ships are purchased using this life cycle model. Eventually, the Navy will be reliant on contractors for all its short lead-time repair parts needs. Algorithms will have to be developed to determine how short the lead-time to manufacture the repair parts needs to be to qualify for the JIT inventory model. Then importance of the repair part to the mission of the ship must also be factored in. In the authors experience with repair parts for surface ships, the lead-time is currently set at 28 days. For example, a supply officer ordering a repair part for a surface ship may need to wait 28 days for a part that is already under contract to have the part manufactured, then the additional two to seven days for transport of the repair part to his location.

Traditionally, when the nation mobilizes for war, industry has responded favorably to providing everything the military needs. Mobilization may be required when fighting two nearly simultaneous major theater wars with the current size of the

Navy. The Navy's surge capacity is therefore reliant on industry's initial response to provide repair parts. If the two major theater wars are longer than six months, mobilization of industry may be needed to provide additional surge capability.

Final Analysis

By comparing each of the conditions for JIT logistics to work with how these conditions affect just-in-case logistics, specific conclusions can be drawn. Just-in-case logistics is not as dependent on transportation as JIT logistics because repair parts are stockpiled and can be moved to different locations as transportation assets become available. JIT logistics cannot be applied to all types of repair parts indiscriminately, so just-in-case logistics practices can coexist with JIT logistics practices. Just-in-case logistics requires more capital because much of the capital is tied up in inventory, whether it gets used or not. JIT logistics requires less money because it does not have capital tied up in repair parts inventory and uses the transportation system more efficiently. It also requires more visibility of repair parts in storage and in transit, making it more flexible and responsive over the entire system. Just-in-case logistics does not require an organization to depend on outside sources to meet its needs, while JIT logistics requires the Navy to rely on its suppliers to meet a substantial portion of its repair parts needs. JIT logistics also requires less warehouse space and inventory management. Finally, by using JIT logistics instead of just-in-case logistics, the Navy has traded actual repair parts that may or may not be used for a promise from suppliers and improved asset visibility to gain additional funds to mitigate the effects of constrained budgets on purchasing required materiel.

## Secondary Questions

Junior and midgrade officers have questioned the ability of JIT logistics to meet the demands of the Navy for repair parts during an actual conflict.[6] As discussed throughout the thesis, JIT logistics will not place additional strain on the Navy supply and transportation systems. It is not applied universally to all repair parts, but only to those items that do not require long-lead times to obtain. The requirements for surface ships during combat remain essentially the same as peacetime. Money is the primary constraint to the repair parts requirements of the Navy during actual combat. The largest risk is associated with the ability of suppliers to meet the Navy's demand for repair parts. Generally, suppliers are in business to make money and remain in business, so they have a significant incentive to deliver on time, too. If they fail to meet Navy requirements, they could be penalized monetarily, the contract could be cancelled and they could lose additional business with the government.

To determine the best logistics system for the Navy working under current budget constraints with its current objectives, three factors should be considered. The Navy requires adequate money, an adequate number and the right types of repair parts and an adequate transportation system. The JIT logistics system does not adversely affect the transportation system and is not applied to repair parts that require long lead times. However, it does decrease the cost of providing repair parts, thus saving money and increasing the flexibility of the logistics system. The JIT logistics system also emphasizes trust in suppliers and a greater dependence on transportation and information. Information requirements are increased in ordering, storing, and tracking materiel; while transportation is relied on to distribute the items. Under current technology, JIT logistics is better than the legacy system and better than other systems available to commercial businesses. As discussed throughout this paper, the Navy's constraints and nature of work do not allow it to implement JIT logistics for repair parts for more than short lead-time items, so the Navy will need to maintain a balance between JIT and just-in-case logistics. The SUP 21 office has responsibility to ensure JIT logistics is applied appropriately. It is beyond the scope of this paper to determine if JIT logistics is being properly applied individually or collectively to categories of materiel. However, the SUP 21 office has acknowledged that criticality of the system, lead-time lengths, and cost savings are factors in determining when to apply JIT logistics.

Repair parts inventories previously created by the Navy were larger than they would be under JIT logistics. The additional size is excess to the needs of the Navy, as noted by the GAO.[7] The same report also notes that some of the inventory items require a long time to obtain, and therefore will not be disposed of until either used or obsolete. As time passes, however, other repair parts in the inventory will decrease as they are used up or redistributed. The JIT logistics system will aid in decreasing the inventory, because generally repair parts will be purchased only on an as needed basis. The rest will not actually get purchased, but will be obtained under contract from suppliers.

Transportation for Navy repair parts is available and adequate in certain areas to support the *National Military Strategy*. However, if a major theater war occurs away from the axis of the two frequency channels, it is not known whether there will be adequate transportation pipelines to move repair parts. In addition, there may not be adequate transportation for other types of supplies, especially personnel transportation. This is because repair parts generally do not require large amounts of space on surface ships, and the USTC has determined transportation requirements for the two frequency channels currently operating.

## Recommendations to Improve Surface Navy Logistics for Repair Parts

The Navy has already embarked on many initiatives to improve its logistics programs. The JTAV program can provide the most benefit in the long term. It should be emphasized at all commands and encouraged until final integration into a single national and perhaps international database with our NATO allies. The Navy should work with the USTC and sister services to improve the visibility of items in transit. There are many new methods of tracking repair parts in transit. The USTC should take advantage of technology and GPS to provide a single database that can be accessed anywhere in the world to provide customers with the latest information on items in transit. The USTC should continue to improve throughput in its frequency channels. By synchronizing transportation modes and hub activities, substantial improvement can be made in reliability of transportation systems and reduction of time to deliver materiel.

The planning cycles of the CINCs and their staffs play a significant role in supporting major theater wars. The quality of the plan produced in the planning cycle can enable the Navy to respond quickly to crisis, and be able to support the fleet over an extended period. If the plan is poor or irrelevant because of lack of intelligence or bad planning, the Navy could be in the wrong location, exposed to increased threat, or unable to support itself. The CINCs should negotiate with host nations to provide potential forward bases and transportation assets in case of a crisis to simplify determining throughput into more remote theaters. Planning before a crisis occurs can greatly increase the Navy's ability to respond rapidly in remote theaters. This may have the greatest effect on improving Navy repair parts supply capability in the future.

Another potential indicator on a high quality, easily deployable fleet would be to examine how the submarine force routinely deploys. It rarely gets the opportunity to receive repair parts while underway, especially the fleet ballistic missile submarines, which routinely operate up to 70 days with no outside support. Part of their success is in the engineering effort to ensure there are multiple backup systems. Another part of their success stems from adequate repair parts funding. The personnel onboard are trained to be completely self reliant while underway, allowing them to be more aggressive in conducting their own repairs. Finally, submarines are engineered to require fewer components and less systems to maintain so there is less to break. They only carry absolutely essential equipment with them.

Finally, the DOD should emphasize the development of methods to counter acts of terrorism, antiship cruise missiles, mines, and submarines. With these threats held in check, the lines of communication will be secure to the theater. In the theater, the Navy must establish early control of the sea to ensure that uninterrupted replenishment can occur.

## Importance of Thesis

The research in this thesis may help guide logistics planning for future contingencies, especially in remote theaters. It also provides information on the ability of JIT logistics to meet the requirements of the surface Navy for repair parts in two nearly simultaneous theater wars. This should aid in increasing confidence in the JIT logistics system as it is implemented throughout the Navy. It also points out some of the limitations of JIT logistics so it can be properly implemented in the future. If JIT logistics is implemented across too large a number of long lead items, the Navy will suffer without repair parts support when it is required most. Conversely, if JIT logistics is restricted from being implemented across a large enough portion of short lead time items, the opportunity to decrease inventory costs will be missed, restricting the money available to purchase critical repair parts or other essential items.

## Applicability Limitations

Several factors can make various aspects of this research less useful or inapplicable. The first is a substantial change in the *National Military Strategy*. If the military were required to support fewer than two nearly simultaneous major theater wars, more transportation assets would be available. Also, the repair parts would not be required to support two theaters. Even with a change in the size of requirements and a shift in availability of assets, the research lays a good foundation of applicable factors affecting JIT logistics and just-in-case logistics. This makes the research applicable in a large variety of circumstances with varying requirements. However, if the role of the military were increased to include support of various military operations other than war and two nearly simultaneous major theater wars, assets would be increasingly limited to support any particular theater. Another more immediate limitation would be a change in the DOD budget, or a realigning of priorities. If readiness was reduced on the priority list while research and development was increased, then fewer transportation assets and repair parts would be available. Conversely, with an increase in funding, the Navy could purchase additional repair parts and stockpile additional material. Presumably, this would be done to make up for known deficiencies in repair parts or deficiencies in other types of material such as Tomahawk missiles.

Other changes that could limit the usefulness of this research include advances in technology. If the military developed a large enough surface vessel that could conduct transits in excess of 100 knots, reliance on air transportation would be reduced drastically, and requirements channel development would be far less important. One type of vessel is the “ground effect transporter,” which uses a wing shaped hull to trap air underneath it so it can ride above the ocean surface. This decreases drag on the hull and increases top speed to around 100 miles an hour, even in moderate seas. Technology can also affect the manufacturing process and potentially could lead to significantly reduced production lead times, enabling JIT logistics to apply to an increasing number of items.

Changes in force structure could change the applicability of this paper. If the number of aircraft carriers required to support two major theater wars were reduced, then requirements would be reduced. Additionally, if the aircraft carrier were considered to be too vulnerable and had to deploy with additional escorts, or the amphibious ready group required additional escorts, then repair parts requirements would go up. If an adversary were able to interdict the sea lines of communication and the Navy were assigned the additional responsibility of escorting merchant shipping, this new requirement might cause a significant strain on the number of repair parts required and increase delays in shipping, waiting for escorts or convoys.

## Additional Research Recommendations

There are several areas where additional research could be conducted. Some are as crucial to the success of the Navy in meeting its requirements as those discussed in this paper. They range from operational problems such as planning for contingencies and strategic transportation problems to individual repair parts problems, such as determining the correct algorithm to determine stocking levels for a single class of repair parts.

The planning process in undeveloped theaters requires additional research. Several questions arose that require answers to determine if the CINCs are doing an adequate job of preparing contingency plans in relation to logistics in undeveloped theaters. Planning would involve USTC to coordinate any requirements channels required. The CINCs need to look at forward bases and establishing agreements with friendly countries to establish these forward bases.

Another area requiring additional research involves the actual application of JIT logistics to the Navy repair parts inventory. There are dozens of logistics models and algorithms available to determine which logistics method should be applied. Each type of item requires an in-depth analysis to determine which model is best for that category.

The scope of this paper was limited to surface Navy repair parts only. There exists a need to review the application of JIT logistics and funding for the aviation community. At least a dozen articles and reports to congress referred to the shortfalls of repair parts for the aviation community. For example, Vice Admiral Amerault said to congress in 1999 when speaking to the House Armed Services Committee about repair parts shortages “we do have more serious lingering problems in aviation.”[8]

Two other classes of material require greater analysis. Ammunition and fuel acquisition and distribution present their own problems. Ammunition provides unique challenges, because much of the information is classified. However, the Navy has noted shortages in certain classes of advanced munitions that could benefit from a close analysis of their logistics requirements. Fuel distribution on the battlefield also provides unique challenges, and would benefit from additional research. Since it is purchased and consumed in bulk quantities, JIT logistics does not apply to it.

Finally, strategic transportation capacities require detailed research to ensure enough assets are available, and organization is synchronized with requirements. USTC has responsibility for meeting the needs of the theater CINCs and must be conducting this analysis to ensure the warfighters can be supported. USTC has initiated projects to improve throughput for the frequency channels. Both require synchronization of assets at the air heads. These projects need to be followed up to ensure they are successful. In addition, USTC needs to be involved with the services to produce a global tracking system to meet the needs of the in-transit visibility (ITV) system.

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[1]Navy Office of Information, "Navy Fact File" [reference list on-line] (5 December 2000, accessed 16 March 2001); available from http://www.chinfo.navy.mil/navpalib/factfile/ffiletop.html; Internet.

[2]Ibid.

[3]SUP 21 Reengineering Office, "SUP 21 Reengineering Office Update." [presentation on-line] (26 January 2000, accessed 26 November 2000); available from http://www.navsup.navy.mil/main/business/sup21/01262000.ppt; Internet, slide 14.

[4]MAJ Steven L. Wade, “Distribution-Based Supply System: Will it Provide More Effective support to the Warfighter?” (Fort Leavenworth, KS: U.S. Army Command and General Staff College, 1999), 9.

[5]“Piloting Reform,” *Government Executive*, September 2000, 43.

[6]Bradley Penniston, “Supply for the 21st Century,” *Sea Power*, October 1999, 54.

[7]David R. Warren, “Report to the Chairman, Subcommittee on National Security, Veteran Affairs, and International Relations, Committee on Government Reform, House of Representatives. Defense Inventory. Status of Inventory and Purchases and their Relationship to Current Needs” (Washington, DC: General Accounting Office, April 1999), 1.

[8]VADM James J. Amerault, “Spare Parts Shortage” (statement presented before the Readiness Subcommittee Committee of the House Armed Services Committee, Washington, DC, 7 October 1999), FDCH Congressional Testimony, AN: 130856625527.
[9]

APPENDIX A

LIST OF SHIP AND AIRCRAFT TYPES AND CHARACTERISTICS

Auxiliary Ships

| Ship type | Characteristics |
|---|---|
| Ammunition Ships - AE | **Length:** 564 feet (169.2 meters)<br>**Beam:** 81 feet (24.3 meters)<br>**Displacement:** Approximately 18,088 tons full load<br>**Speed:** 20 knots (23 miles, 36.8 km, per hour)<br>**Cargo:** Ammunition |
| Ammunition Ships - T-AE | **Length**: 564 feet (171.9 meters)<br>**Beam**: 81 feet (24.7 meters)<br>**Displacement**: 9,340 tons (9,489.89 metric tons) light; 19,940 tons (20,260 metric tons) full load<br>**Speed**: 20 knots<br>**Cargo:** Ammunition |
| Advanced Auxiliary Dry Cargo Ships – T-AKE | **Length**: 689 feet (210 meters)<br>**Beam**: 106 feet (32.31 meters)<br>**Draft**: 29.5 feet (8.99 meters)<br>**Full Load Displacement**: 35,400 long ton (359,681 metric tons)<br>**Speed**: 20 knots (23 mph)<br>**Max Dry Cargo Weight**: 5,910 long ton (6,004.84 metric tons)<br>**Max Dry Cargo Volume**: 783,000 feet<br>**Max Cargo Fuel Weight**: 2,350 long ton (2,387.71 metric tons)<br>**Cargo Fuel Volume**: 18,000 barrels (DFM: 10,500) (JP5:7,500)<br>**Cargo:** ammunition, food, limited quantities of fuel, repair parts, ship store items, and expendable supplies and material |
| Fast Combat Support Ships - AOE | **Length:** 754 feet (229.9 meters)<br>**Beam:** 107 feet (32.6 meters)<br>**Displacement:** 48,800 tons (49,583.15 metric tons) full load<br>**Speed:** 25 knots<br>**Cargo:** 177,000 barrels of oil, 2,150 tons of ammunition, 500 tons of dry stores and 250 tons of refrigerated stores |

| Ship type | Characteristics |
|---|---|
| Combat Stores Ships - T-AFS | **Length:** 581 feet (177.1 meters)<br>**Beam:** 79 feet (24.1 meters)<br>**Displacement:** 9,200 tons (9,347.64 metric tons) light ; 15,900-18,663 tons (16,155.17 - 18,962.51 metric tons) full load<br>**Speed:** 21 knots (24.15 mph)<br>**Cargo:** repair parts, supplies, including frozen, chilled and dry provisions |
| Underway Replenishment Oilers - T-AO | **Length:** 677.5 feet (206.5 meters)<br>**Beam:** 97.5 feet (29.7 meters)<br>**Displacement:** 40,700 tons (41,353.16 metric ton); 42,000 tons (42,674.02 metric tons) [T-AO 201, 203-204] full load<br>**Speed:** 20 knots (23 mph)<br>**Cargo:** 180,000; 159,000 [T-AO 201, 203-204] barrels of fuel oil or aviation fuel |

Aircraft Carriers

| Ship type | Characteristics |
|---|---|
| Aircraft Carriers - CV, CVN | **Length, overall:** 1,092 feet (332.85 meters)<br>**Flight Deck Width:** 252 feet (76.8 meters)<br>**Beam:** 134 feet (40.84 meters)<br>**Displacement:** Approx. 97,000 tons (98,556.67 metric tons) full load<br>**Speed:** 30+ knots (34.5+ miles per hour)<br>**Aircraft:** 85<br>**Purpose:** Carries attack and air superiority aircraft for power projection, as well as various auxiliary aircraft<br>**Note:** Characteristics are for the NIMITZ class aircraft carrier, the predominant carrier in the fleet.  Conventional carriers are approximately 80,000 tons with a similar complement of aircraft. |

Amphibious Ships

| Ship type | Characteristics |
| --- | --- |
| Amphibious Assault Ships - LHA/LHD | **Length:** 844 feet (253.2 meters)<br>**Beam:** 106 feet (31.8 meters)<br>**Displacement:** Approx. 40,500 tons (41,150 metric tons) full load<br>**Speed:** 20+ knots (23.5+ miles per hour)<br>**Aircraft:**<br>Assault: 42 CH-46 *Sea Knight* helicopters<br>Sea Control: 5 AV-8B *Harrier* attack planes; Six ASW helicopters<br>**Purpose:** Carries Marine units, assault vehicles, landing craft and command and control facilities for power projection<br>**Note:** Characteristics are for the WASP class LHD. The TARAWA class LHA is approximately 39,000 tons with a similar mix of aircraft. |
| Amphibious Command Ships - LCC | **Length overall:** 634 feet (190 meters)<br>**Beam extreme:** 108 feet (32 meters)<br>**Displacement:** 18,874 tons (19,176.89 metric tons) full load<br>**Speed:** 23 knots (26.5 miles, 42.4 km, per hour)<br>**Purpose:** Provide command and control facilities for fleet and amphibious operations, including large communications suite. |
| Command Ships - AGF | **Length:** 520 feet (158 meters)<br>**Beam:** 84 feet (26 meters)<br>**Displacement:** 14,650 tons (14,885.10 metric tons)<br>**Speed:** 20 knots<br>**Purpose:** Provide command and control facilities for fleet and amphibious operations, including large communications suite. |

| Ship type | Characteristics |
|---|---|
| Amphibious Transport Dock - LPD 17 | **Length:** 684 feet (208.5 meters)<br>**Beam:** 105 feet (31.9 meters)<br>**Displacement:** Approximately 24,900 tons (25,300 metric tons) full load<br>**Speed:** in excess of 22 knots (24.2 mph, 38.7 kph)<br>**Aircraft:** Launch or land up to four CH-46 *Sea Knight* helicopters; or up to two MV-22 *Osprey* tilt rotor aircraft<br>**Landing Craft/Assault Vehicles:** Two LCACs or one LCU; and 14 Advanced Amphibious Assault Vehicles<br>**Purpose:** Carries Marine units and smaller command and control facilities than LHDs for power projection. |

Battle Group Submarines

| Ship type | Characteristics |
|---|---|
| Attack Submarines - SSN | **Length:** 360 feet (109.73 meters)<br>**Beam:** 33 feet (10.06 meters)<br>**Displacement:** Approx. 6,900 tons (7010.73 metric tons) submerged<br>**Speed:** 20+ knots (23+ miles per hour, 36.8 +kph)<br>**Purpose:** When operating with surface ships, protect the battle group, locate and destroy enemy submarines, launch Tomahawk missiles for power projection. |

Mine Countermeasures Ships

| Ship type | Characteristics |
|---|---|
| Coastal Mine Hunters - MHC | **Length:** 188 feet (57.3 meters)<br>**Beam:** 36 feet (11 meters)<br>**Displacement:** 893 tons (907.33 metric tons) full load<br>**Speed:** 10 knots (18.4 kmph)<br>**Purpose:** Locate and neutralize mines in restricted waters |
| Mine Countermeasures Ships - MCM | **Length:** 224 feet (68.28 meters)<br>**Beam:** 39 feet (11.89 meters)<br>**Displacement:** 1,312 tons (1,333.06 metric tons) full load<br>**Speed:** 14 knots (16.1 mph, 25.76 kmph)<br>**Purpose:** Deploy to locate and neutralize mines in unrestricted waters |

| Ship type | Characteristics |
|---|---|
| Mine Countermeasures Ship - MCS | **Length:** 602 feet (183.5 meters)<br>**Beam:** 84 feet (25.6 meters)<br>**Displacement:** 19,600 tons (19,914.54 metric tons) full load<br>**Speed:** 21 knots (24 miles per hour)<br>**Aircraft:** Two UH-46D *Sea Knight* helicopters and eight MH-53E *Sea Stallion* helicopters<br>**Purpose:** Deploy to support and provide command and control for mine hunting operations. Provides support to MCMs and MHCs, as well as deploys MH-53E helicopters. |

Surface Combatant Ships

| Ship type | Characteristics |
|---|---|
| Cruisers - CG | **Length:** 567 feet<br>**Beam:** 55 feet<br>**Displacement:** 9,600 tons (9,754.06 metric tons) full load<br>**Speed:** 30 plus knots<br>**Aircraft:** Two SH-60 *Sea Hawk* (LAMPS III)<br>**Purpose:** Air defense, submarine defense, surface attack, and strike |
| Destroyers - DDG | **Length:**<br>**Flights I and II (DDG 51-78):** 505 feet (153.92 meters)<br>**Flight IIA (DDG 79-98):** 509½ feet (155.29 meters)<br>**Beam:** 59 feet (18 meters)<br>**Displacement:** 8,300 tons (8,433.2 metric tons) full load<br>**Speed:** in excess of 30 knots<br>**Aircraft:** None for Flights I and II. LAMPS III electronics installed on landing deck for coordinated DDG 51/helo ASW operations. Up to two SH-60 *Seahawk* LAMPS III helicopters for Flight IIA.<br>**Purpose:** Air defense, submarine defense, surface attack, and strike |
| Destroyers - DD | **Length:** 563 feet (171.6 meters)<br>**Beam:** 55 feet (16.8 meters)<br>**Displacement:** 9,100 tons (9,246.04 metric tons) full load<br>**Speed:** in excess of 30 knots<br>**Aircraft:** Two SH-60 *Seahawk* LAMPS III helicopters<br>**Purpose:** Submarine defense, surface attack, and strike |

| | |
|---|---|
| Frigates - FFG | **Length:** 445 feet (133.5 meters); 453 feet (135.9 meters) with LAMPS III modification.<br>**Beam:** 45 feet (13.5 meters)<br>**Displacement:** 4,100 tons (4,165.80 metric tons) full load<br>**Speed:** 29 plus knots (33.4+ miles per hour)<br>**Aircraft:** Two SH-60 (LAMPS III) helicopters<br>**Purpose:** Primarily convoy protection. Can perform Submarine defense, and to a limited degree air defense |

| Landing craft<br>Boat type | Characteristics |
|---|---|
| Landing Craft, Air Cushioned - LCAC | **Length:** 87 feet 11 inches (26.4 meters)<br>**Beam:** 47 feet (14.3 meters)<br>**Displacement:** 87.2 tons (88.60 metric tons) light; 170-182 tons (172.73 - 184.92 metric tons) full load<br>**Range:** 200 miles at 40 kts with payload / 300 miles at 35 kts with payload<br>**Speed:** 40+ knots (46+ mph; 73.6 kph) with full load<br>**Load Capacity:** 60 tons / 75 ton overload<br>**Military lift:** 24 troops or 1 MBT<br>**Purpose:** High speed transport of Marine units and equipment to the objective ashore. |
| Landing Craft, Mechanized and Utility - LCM/LCU | **Length:** 134.9 feet (41.1 meters)<br>**Beam:** 29 feet (8.8 meters)<br>**Displacement:** 200 tons (203.21 metric tons) light; 375 tons (381.02 metric tons) full load<br>**Speed:** 11 kts (12.7 mph, 20.3 kph)<br>**Range:** 1200 miles at 8 knots<br>**Capacity:** 170 tons (172.73 metric tons)<br>**Military Lift:** 125 tons of cargo<br>**Purpose:** Medium and heavy lift of material and Marine units to the shoreline.<br>**Note:** LCU characteristics are listed. LCMs are approximately 105 tons and 64 tons displacement. |

Logistics Aircraft

| Aircraft type | Characteristics |
|---|---|
| C-5 Galaxy | **Length:** 247.1 feet (75.3 meters)<br>**Height:** 65.1 feet (19.84 meters)<br>**Wingspan:** 222.9 feet (67.89 meters)<br>**Speed:** 518 mph (.77 Mach)<br>**Range:** 6,320 nautical miles (empty)<br>**Cargo Compartment:** height , 13.5 feet (4.11 meters); width, 19 feet (5.79 meters); length, 143 feet, 9 in (43.8 meters)<br>**Pallet Positions:** 36<br>**Maximum Cargo:** 270,000 pounds (122,472 kilograms)<br>**Maximum Takeoff Weight: C-5B** 769,000 pounds (348,818 kilograms) (peacetime), 840,000 pounds (381,024 kilograms) (wartime)<br>**Purpose:** outsized-cargo intertheater airlift. It can carry outsized cargo (larger than standard Air Force pallets) intercontinental ranges, such as M1-A2 tanks. |
| C-17 Globemaster III | **Length:** 174 feet (53 meters)<br>**Height:** 55 feet 1 inch (16.79 meters)<br>**Wingspan:** 169 feet 10 inches (to winglet tips) (51.75 meters)<br>**Speed:** 450 knots at 28,000 feet (8,534 meters) (Mach .74)<br>**Service Ceiling:** 45,000 feet at cruising speed (13,716 meters)<br>**Range:** Global with in-flight refueling<br>**Cargo Compartment: length**, 88 feet (26.82 meters); **width**, 18 feet (5.48 meters); **height**, 12 feet 4 inches (3.76 meters)<br>**Maximum Peacetime Takeoff Weight:** 585,000 pounds (265,352 kilograms)<br>**Load:** 102 troops/paratroops; 36 litter and 54 ambulatory patients and attendants; 170,900 pounds (77,519 kilograms) of cargo (18 pallet positions)<br>**Purpose:** outsized-cargo intertheater airlift. It can carry outsized cargo (larger than standard Air Force pallets) intercontinental ranges, such as vehicles smaller than tanks and armored personnel carriers. |

| | |
|---|---|
| C-130 Hercules | **Length:** 97 feet 9 inches (29.3 meters)<br>**Height:** 38 feet 3 inches (11.4 meters)<br>**Wingspan:** 132 feet 7 inches (39.7 meters)<br>**Speed:** 374 mph (Mach 0.57, 604.4 kmh) at 20,000 feet<br>**Ceiling:** 33,000 feet with 100,000 pounds (45,000 kg) payload<br>**Maximum Takeoff Weight:** 155,000 pounds (69,750 kg)<br>**Range:** 2,350 miles (2,050 nautical miles, 3,770 km) with maximum payload; 2,500 miles (2,174 nautical miles, 4,000 km) with 25,000 pounds (11,250 kg) cargo; 5,200 miles (4,522 nautical miles, 8,320 km) with no cargo<br>**Cargo:** Up to 92 troops or 64 paratroops or 74 litter patients or five standard freight pallets<br>**Purpose:** Provide theater lift to prepared and unprepared runways |
| C-2A Greyhound | **Length:** 57 feet 7 inches (17.3 meters)<br>**Height :** 17 feet (5 meters)<br>**Weight:** Max. gross, take-off: 57,000 lbs (25,650 kg)<br>**Cruising Speed:** Max.: 300 knots (345 miles, 553 km, per hour)<br>**Ceiling:** 30,000 feet (9,100 meters)<br>**Range:** 1,300 nautical miles (1,495 statute miles)<br>**Purpose:** Provide carrier onboard delivery of material and personnel |
| C-40A Clipper | **Length:** 110 feet 4 inches (33.63 meters)<br>**Height:** 41 feet 2 inches (12.55 meters)<br>**Wingspan:** 112 feet 7 inches (34.3 meters)<br>**Weight:** Max. gross, take-off: 171,000 lbs (77,564.3kg)<br>Taxi: 171,000 lbs (77,564.3 kg)<br>Landing: 134,000 lbs (60,781.4 kg)<br>Zero fuel: 126,000 lbs (57152.6 kg)<br>**Cruising Speed:** Range: 0.78 to 0.82 Mach (585 to 615 mph, 941.47 to 989.75 kph)<br>**Ceiling:** 41,000 feet (12,496.8 meters)<br>**Range:** 3,000 nautical miles (3,452.34 statute miles) with 121 passengers or 40,000 lbs. (18,144 kg) of cargo<br>**Purpose:** Provide theater and strategic lift to prepared runways |

| | |
|---|---|
| C-9 Skytrain | **Length:** 119 feet 3 inches (35.7 meters)<br>**Wingspan:** 93 feet 3 inches (27.9 meters)<br>**Height:** 27 feet 5 inches (8.2 meters)<br>**Maximum Takeoff Weight:** 108,000 pounds (48,600 kg)<br>**Range:** More than 2,000 miles (1,739 nautical miles or 3,200 km)<br>**Basic Weight:** 65,283 pounds (29,369 kg) in passenger configuration, 59,706 pounds (26,868 kg) in cargo configuration<br>**Ceiling:** 37,000 feet<br>**Speed:** 565 mph (Mach 0.86/904 km/h) at 25,000 feet ( 7,500 meters), with maximum takeoff weight<br>**Cargo:** 40 litter patients or four litters and 40 ambulatory patients or other combinations<br>**Purpose:** Provide theater and strategic lift to prepared runways |
| V-22A Osprey | **Weight:** 60,500 lbs max gross weight<br>**Ceiling:** 25,000 feet (sevice ceiling)<br>**Speed:** 272 knots (cruise speed)<br>**Purpose:** Provide high-speed transport to Marine units and equipment to the objective ashore |
| MH-53E Sea Dragon | **Length:** Fuselage: 73 feet 4 inches (22.34 meters)<br>Overall: 99 feet (30.18 meters)<br>**Height:** 28 feet 4 inches (8.63 meters)<br>**Weight:** 21 tons (max gross) (18.9 metric tons)<br>**Main Rotor Diameter:** 72 feet 3 inches (21.7 meters)<br>**Range:** 1,120 nautical miles (1,289 statute miles, 1802 km)<br>**Ceiling:** 27,900 feet<br>**Speed:** 150 knots (172 miles per hour, 241 km per hour)<br>**Purpose:** Mine hunting.  Alternate configurations for heavy lift transport to Marine units and equipment to the objective ashore. |

| | |
|---|---|
| CH-53D Sea Stallion | **Length:**<br>**Fuselage**: 67.5 feet (20.3 meters)<br>**Rotors turning**: 88 feet 3 inches (26.5 meters)<br>**Height:** 24 feet 11 inches (7.2 meters)<br>**Weight:** 21 tons (max gross) (18.9 metric tons)<br>**Main Rotor Diameter:** 72 feet 3 inches (21.7 meters)<br>**Range:** 578 nautical miles (665 statute miles, 1064 km); 886 nautical miles ferry range<br>**Ceiling:** 12,450 feet<br>**Speed:** 160 knots (184 miles, 294 km per hour)<br>**Cargo:** 37 troops or 24 litter patients plus four attendants or 8,000 pounds (3,600 kg) cargo<br>**Purpose:** Provide medium lift logistics support to amphibious forces and medium lift to Marine units and equipment to the objective ashore.<br>**Note:** Operated only in reserve squadrons |
| CH-46D/E Sea Knight | **Length:** 45 feet, 8 inches (13.89 meters) with rotors folded<br>84 feet, 4 inches (25.7 meters) with rotors spread<br>**Width:** 51 feet (15.54 meters) with rotors spread<br>**Height:** 16 feet 8 inches (5.08 meters)<br>**Maximum Takeoff Weight:** 24,300 pounds (11,032 kg)<br>**Range:** 132 nautical miles (151.8 miles) for land assault mission<br>**Speed:** 145 knots (166.75 miles per hour)<br>**Ceiling:** 10,000 feet plus<br>**Cargo:** Combat: max. of 22 troops and two aerial gunners<br>Medical evacuation: 15 litters, two attendants<br>Cargo: 5,000 pounds (2270 kg) maximum<br>**Purpose:** Provide lift to Marine units and equipment to the objective ashore. Alternate configurations to provide logistics support from auxiliary ships to surface ships. |

Strike Aircraft

| Aircraft type | Characteristics |
|---|---|
| F/A 18 E/F Hornet | **Unit Cost:** $ 35 million<br>**Length:** 60.3 feet (18.5 meters)<br>**Height:** 16 feet (4.87 meters)<br>**Maximum Take Off Gross Weight:** 66,000 pounds (29,932 kg)<br>**Wingspan:** 44.9 feet (13.68 meters)<br>**Ceiling:** 50,000+ feet<br>**Speed:** Mach 1.8+<br>**Purpose:** Multi-role attack and fighter aircraft |

Source: Navy Office of Information, "Navy Fact File" [reference list on-line] (5 December 2000, accessed 16 February 2001); available from http://www.chinfo.navy.mil /navpalib/factfile/ffiletop.html; Internet.

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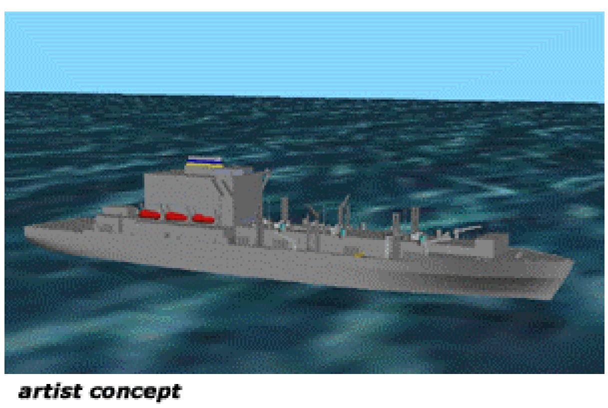
APPENDIX B

PICTURES OF SHIP AND AIRCRAFT TYPES

Auxiliary Ship Types

Ammunition Ships - AE

Ammunition Ships - T-AE




Advanced Auxiliary Dry Cargo Ships – T-AKE

Fast Combat Support Ships - AOE

Combat Stores Ships - T-AFS

Underway Replenishment Oilers - T-AO

Aircraft Carriers

Aircraft Carriers - CV, CVN

Amphibious Ship Types

Amphibious Assault Ships - LHA/LHD


Amphibious Transport Dock - LPD 17

Command Ship Types

Amphibious Command Ships - LCC

Command Ships - AGF

Battle Group Submarines

Attack Submarines - SSN

Mine Countermeasures Ship Types

Coastal Mine Hunters - MHC

Mine Countermeasures Ships - MCM

Mine Countermeasures Ship - MCS

Surface Combatant Ship Types

Cruisers - CG

Destroyers - DDG

Destroyers - DD

Frigates - FFG

Landing Craft Boat Types

Landing Craft, Air Cushioned - LCAC


Landing Craft, Mechanized and Utility - LCM/LCU

Logistics Aircraft Types


C-5 Galaxy


C-17 Globemaster III

C-130 Hercules


C-2A Greyhound


C-40A Clipper

C-9 Skytrain

V-22A Osprey

MH-53E Sea Dragon


CH-53D Sea Stallion


CH-46D/E Sea Knight

Attack Aircraft


F/A 18 E/F Hornet

Source: Navy Office of Information, “Navy Fact File” [reference list on-line] (5 December 2000, accessed 16 February 2001); available from http://www.chinfo.navy.mil /navpalib/factfile/ffiletop.html; Internet.

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## GLOSSARY

Aerial port of debarkation (APOD): An airport in the theater of operations or at the intermediate staging base used to unload material for further transfer to other modes of transportation.

Aerial port of embarkation (APOE): An airport at receiving points or at an intermediate staging base used to load material from other modes of transportation onto aircraft for transfer to APODs.

Carrier onboard delivery (COD): A fixed-wing aircraft delivers material and personnel to an aircraft carrier from shore or another aircraft carrier.

Choke point: A restricted waterway along a major sea line of communication. Generally, these require considerable time to bypass, or they are completely impassable by maritime assets.

Contractor Logistics Support (CLS): A single vendor manages the overall logistics process for an entire weapon system, including repair parts management, technical manuals, field upgrades, and maintenance in certain cases. This is more comprehensive than life cycle management, because the Navy still manages the logistics process and the vendor provides the repair parts and, in certain circumstances, the shipping costs.

Defense Logistics Agency (DLA): It manages materiel and supplies for the Defense Department that is not carried individually by the services. DLA's mission includes managing over 4 million consumable items and processing more than 30 million annual distribution actions.[1]

Demand based logistics model: Specific formulas are used to determine the quantity of material required to meet a specific need for a certain length of time. Depending on the level at which items are being stocked, the time used for the calculations can vary from days at the lowest levels to years at the national level.

Direct Vendor Delivery (DVD): Contracts are established to have material delivered directly to the user, vice to a central receiving point or storage location.

Focused logistics: The ability to provide the joint force the right personnel, equipment, and supplies in the right place, at the right time, and in the right quantity, across the full range of military operations. This will be made possible through a real-time, web-based information system providing total asset visibility as part of a common relevant operational picture, effectively linking the operator and logistician across Services and support agencies. Through transformational innovations to organizations and processes, focused logistics will provide the joint warfighter with support for all functions.[2]

Force in being: A unit or group of units whose mission does not require them to engage the enemy to accomplish their mission. They are used to deny the enemy its ability to use certain portions of its forces in other operations because any course of action must take into consideration the force in being as if it may engage the enemy.

Forward presence: The use of military units to demonstrate commitment to an area or provide a show of force in a region. The Navy traditionally conducts forward presence missions since international waters are not subject to restrictions as land based forces are. In addition, Naval forces provide more permanent presence than aircraft because of the high endurance built into US Naval platforms.

Free on board (FOB): A shipping term to describe where responsibility of material is transferred. When material is FOB destination, the supplier is responsible for providing the shipping costs to the destination. When material is FOB shipping point, the requiring activity is responsible for the items from that point to the location of use, including the shipping costs.

Frequency channel: Airlift transportation routes established by the US Transportation Command with specific known throughput capacities. They include the aircraft assigned to that route, airports, ground transportation, and material handling equipment.

Frustrated material: Items or pallets of material that have been mislabeled or lost at a shipping point and cannot be forwarded to their final destinations without additional research. Additional research includes contacting the original shipper, opening the container to determine if there are shipping labels inside the box, or conducting an inventory of material at the shipping location to locate missing material.

Intermediate staging base: A base established near a theater of operations to provide logistics and staging support to operations occurring in the theater. They are chosen based on protection, capacity, and location in relation to operations.

International Maritime Satellite (INMARSAT): Commercial telephone communication links to the telephone systems of the world. Ships routinely use it to conduct logistics transactions and other functions requiring telephone communications.

In-transit visibility (ITV): It is the ability to track material from its storage location to its final destination. There are several methods being developed to increase ITV across industry and the military.

Just-in-time II (JIT II): Purchasing integration with suppliers designed to eliminate buyers, planners and sales representatives. It is designed to increase cooperation between suppliers and manufacturers and to reduce costs associated with the purchasing function, such as labor and infrastructure.

Just-in-time logistics (JIT logistics): The Navy's application of JIT systems from civilian industry is termed JIT logistics. JIT systems in civilian industry means order placement and delivery that is synchronized with production schedules to reduce or minimize inventory costs.[3] This includes reducing inventories to zero or near zero and ordering material in the smallest batch sizes possible to realize savings in various areas from inventory management to manufacturing and production processes. Since the DOD and the Navy do not produce physical items, or manufacture particular materials, the part of civilian JIT systems that applies to the Navy is JIT inventory management and JIT purchasing procedures. These areas rely on a robust transportation capability and Total Asset Visibility (TAV).

Joint Total Asset Visibility (JTAV): The capability to provide users with timely and accurate information on the location, movement, status, and identity of units, personnel, equipment and supplies for the military and the military-industrial complex. It includes in-process, in-storage and in-transit business practices.[4]

Just-in-case logistics: Items are stocked based on criticality of the item to a system. It is not demand based, but based on the requirement to ensure that the item is always available because the system will not function without it.

Life cycle management: A contract for the life cycle of a larger assembly will include the supply of repair parts, depot level maintenance and repair services. Standards are established for repair parts in the contracts for delivery times and amounts required to be on hand. The contractor will also be required to provide configuration information and recommend upgrades and field changes.

Littoral environment: The area where navigable waters meet shallow water and the land adjacent to the shallow water.

Major Theater War (MTW): Large military operations that occur in a geographically specific region of the world. War is considered the most demanding of military operations, and US forces are expected to defeat any adversary and control any situation across the full range of military operations.[5]

Maritime supremacy: The adversary is not able to mount a credible threat against the Navy or other supply vessels.

Military Sealift Command (MSC): Responsible for sealift and logistics to all military departments. They possess ships and crews to provide logistics support to Navy ships at sea and they operate ships with pre-positioned assets for all services. They also maintain contracts with merchant shipping companies for emergency sealift.

Naval Inventory Control Point (NAVICP): Managers of all items specific to Navy systems. They also manage items that are in common with other systems in other services when they are designated the lead agent. They provide program and supply support for the systems that keep Naval forces mission ready.[6]

Navy WorkingCapital Fund (NWCF): A rotating fund to supply the Navy with material managed by the NAVICP. It uses funds generated by the sale of material to organizations to purchase new stocks of material.

One Touch Supply: An integrated system of networks for providing customers a single point of entry for all logistics needs, to include repair parts, consumables, technical manuals, and technical assistance.

Power projection: The ability to provide combat power at significant distances from the origin of the unit providing that power. This includes the types of weapons used and the ability to deploy the units.

Pre-positioned assets: Assets placed in storage either on ships or in critical areas around the world to provide a rapid response in a particular theater. The pre-positioned assets on ships provide additional flexibility because they can be quickly moved to the theater of operations, even if it is a different theater than originally intended.

Readiness Based Sparing (RBS): A relatively new model to compute amount of repair parts to hold in inventory taking into account an entire systems criticality, number of times the repair part fails, number of times other parts in the system fail, and length of time it takes to receive the repair part.

Replenishment at Sea (RAS): The process of transferring material while ships are still underway, without having to enter port or stop. RAS takes three forms, vertical replenishment by helicopter, connected replenishment when two ships connect to each other (only method for transferring fuel), and carrier onboard delivery where a fixed-wing aircraft delivers material and personnel to an aircraft carrier from shore or another aircraft carrier.

Requirements channel: Airlift routes established when a service requests them based on the volume of cargo. They include the aircraft assigned to that route, airports, ground transportation, and material handling equipment.

Seaport of Debarkation (SPOD): A seaport in the theater of operations or at the intermediate staging base used to unload material for further transfer to other modes of transportation.

Socioeconomic programs: Programs established by the U.S. government to provide maximum practicable opportunities to disadvantages people and business concerns. The Small Business Administration manages them.[7]

Streamlined Automated Logistics Transmission System (SALTS): A system designed during the Gulf War in 1991 to alleviate problems transmitting logistics requirements from the Persian Gulf. It uses INMARSAT commercial telephone lines to pass information in compressed format to the NAVICP in the U.S.

SUP 21: A new organization to coordinate modernization initiatives in the Navy supply system. A board of professional logisticians reviews and establishes timelines and priorities, as well as monitoring progress, to coordinate efforts to achieve efficient modernization of the Navy supply system.

Third Party Logistics (3PL): A contractor is brought in to manage a supply system for a certain group of items.

Total Asset Visibility (TAV): The capability to provide users with timely and accurate information on the location, movement, status, and identity of units, personnel, equipment and supplies for the Navy. It includes in-process, in-storage and in-transit business practices.[8]

Visit, Board, Search and Seizure (VBSS): A procedure to verify the legitimacy of material and personnel being carried on a vessel. It consists of querying the vessel, sending a boarding party to it, conducting an inspection, and determining if there is contraband aboard.[9]

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[1]"What is DLA?" [article on-line] (Fort Belvoir, VA: Public Affairs Division of Corporate Communications of DLA, accessed 26 November 2000); available from http://www.dla.mil/about_dla.asp; Internet.

[2]Director for Strategic Plans and Policy (J-5), Joint Chiefs of Staff, *Joint Vision 2020* (Washington, DC: United States Government Printing Office, June 2000), 24.

[3]Matthew D. Cox, "WWW Virtual Library of Logistics, version 4." [library on-line] (St Athan, Barry, Vale of Glamorgan CF62 4LB Wales, United Kingdom: Logistics World, 4 September 1999, accessed 30 September 2000); available from http:// 209.51.193.25/logistics/terminology.htm; Internet.

[4]Director of Logistics (J-4), Joint Chiefs of Staff. *Joint Vision 2010, Focused Logistics, A Joint Logistics Roadmap* (Washington, DC: United States Printing Office, 1996), 18.

[5]Director for Strategic Plans and Policy (J-5), Joint Chiefs of Staff. *Joint Vision 2020*, 6.

[6]"About NAVICP" [article on-line] (Mechanicsburg, VA: Public Affairs Office of NAVICP, 25 July 2000, accessed 26 November 2000); available from http://www.navicp.navy.mil/abouticp/index.htm; Internet.

[7]Aaron Broaddus, *Federal Acquisition Regulation* (Chicago, IL: CCH Inc., June 2000), part 19.201.

[8]Director of Logistics (J-4), Joint Chiefs of Staff. *Joint Vision 2010, Focused Logistics, A Joint Logistics Roadmap*, 18.

[9]JO1 Jason Chudy, "6th Fleet command ship gets "captured" during VBSS exercise." [article on-line] (Washington, DC: Navy Office of Information, 25 August 2000, accessed 6 April 2001), available from http://www.chinfo.navy.mil/navpalib/news/navywire/nws00/nws000825.txt; Internet.

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